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CIVIL ENGINEERING.

The Dynamical Deflection and Strain of Railway Girders.

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There is no subject in practical science which has been more elaborately investigated than the theory of the statical transverse strength of beams. It has fortunately happened that two different classes of investigators—mathematicians and experimentalists—have co-operated in the research; and the result of their united labors has been a valuable and comprehensive system of knowledge.

But the DYNAMICAL strength of beams, or their capability of sustaining weights moving rapidly over them, has never been satisfactorily discussed. There does not appear to be extant a single theoretical investigation of this subject—and the deficiency is due to two causes: it occurs partly because the subject has but comparatively recently grown into importance; partly because of its excessive and insuperable difficulties when investigated by the exact methods of theoretical mechanics. The following paper is a contribution to a more accurate knowledge of this important question, which has at length attracted the attention due to its influence on the security of railway traffic. The necessity of further inquiry seems to be generally acknowledged among engineers; and by the recommendation of the Commissioners of Railways, in a published minute of the 29th of June, 1847, a government commission has been appointed for the very purpose. The minute expresses a doubt "whether the experimental data and the theoretical principles at present known are adequate" for the "designing

iron bridges, when these are to be traversed by loads of extraordinary weight at great velocities."

There seems to exist great discrepancy of opinion as to the effect of the velocity of transit. Some have imagined that it may become a source of safety, by causing the railway train to pass over before the girder has had time to yield. Others, again, have estimated the effect of the moving load as highly as six or seven times that of the same load at rest. In the following investigation, both these opinions will be shown to be incorrect: they are here cited merely as indications of the extreme uncertainty prevalent on the subject.

The method of inquiry about to be explained consists, not in determining the dynamical strain absolutely, but by comparison with the corresponding statical strain. The results will consequently be much simpler than they would be if the dynamical strain were estimated independently. The deflection which a given load *at rest* upon a girder produces, will be always taken as one of the known data of the problem. The determination of this statical deflexion, as it forms the basis of all the remaining calculations, is the first point of inquiry.

When a beam is not affected by a permanent set or defect of elasticity, it appears, both from theory and actual experiment, that the deflexion by a weight resting at its centre, is very nearly proportional to that weight—that is, if a given number of tons deflect it one inch, double the number of tons will deflect it two inches. This result is arrived at by Professor Mosely in his "Mechanical Principles of Engineering," and M. Navier in his "Resumè de Leçons de Construction," by independent methods. Its near accordance with practical truth has been abundantly confirmed by experiment, as may be verified by reference to numerous published accounts of actual observations on the subject, and especially to Mr. Hodgkinson's invaluable "Experimental Researches on the Strength of Cast-Iron." This work gives the results of an exceedingly large number of experiments, made by the author and others, on the transverse strength of beams loaded at their centres; and although these beams were of very different forms and dimensions, the law indicated is nearly observed in all of them. Whether the section of the beam be rectangular, triangular, or T-shaped, with the vertical rib either upwards or downwards, the constant ratio, in each beam, of each deflexion to the corresponding load is nearly maintained: and the same remark applies to beams of the form most useful for railway purposes—that of an upper and lower flange connected by a vertical rib.

It will be found, however, by reference to the tables of Mr. Hodgkinson's work, that the actual deflexions are somewhat more than the theoretical law would make them. This discrepancy may be accounted for by attributing it to the defect of elasticity, which the ordinary theory of beams does not consider. As this defect is not generally very great, it will here in the first instance be neglected: the deflexions will primarily be estimated as if the elasticity were perfect; and subsequently the modifications due to defect of elasticity will be taken into consideration.

Work Done on the Deflexion of a Beam.

The "work done" by a moving force may be defined to be the product

of that force into the distance through which it acts. A familiar instance of the use of this measure is the Steam-Engine; where the work done receives the particular name of Horse-Power. If the pressure on the piston were uniform, that pressure (in pounds) multiplied by the distance through which it is exerted (in feet) would, if divided by 33,000, give the horse-power. But in the steam-engine, and all other practical instances, where the pressure is not uniform, but varying, it is impossible to calculate the work done by this direct multiplication. Where the value of the moving force is constantly altering, we may resort to either of the following methods of ascertaining the work done by it,—we may multiply its *average* value by the distance through which it acts; or, when that average cannot be ascertained, we may consider the whole distance divided into elementary portions, so small that it may be supposed without sensible error—that the pressure is at least uniform while it acts through each portion in succession. The aggregate work done, is the sum of the work done on each of these portions—that is, it is the sum of the products of each portion of the distance and the corresponding pressure.

This process of summation when carried out with the greatest possible accuracy, is equivalent to that of mathematical integration; in which case, the work done by a varying pressure may be defined, in mathematical language, to be the integral of the product of the pressure, and its "virtual velocity." The work done in deflecting a beam by pressure at its centre is easily ascertained, if that pressure be assumed proportional to the deflexion. Calling the deflexion x, and therefore the pressure $a x$, (where a is a constant depending on the dimensions, &c. of the beam,) we have—

$$\text{work done} = \int_0^x a x \, dx = \frac{a x^2}{2} = \frac{a x}{2} \cdot x.$$

Now $\frac{a x}{2}$ is the pressure or weight which would statically maintain half the deflexion x. Hence *the work done in producing a given deflexion is equal to the weight which would statically maintain half the deflexion, multiplied by the whole distance of deflexion.*

The value of this rule will appear hereafter.

Distinction of Gradual and Instantaneous Loading.

When experiments are made on the strength and deflexion of beams, they are generally loaded very gradually at their centres. Each addition to the load is allowed to produce its full effect before more be imposed. Consequently, at every stage of the experiment, the beam is in a state of statical equilibrium: the pressure of the load on the beam is always just equal to its weight, and is never increased by any momentum arising from downward velocity.

But if the whole load be suddenly and at once placed on the beam, while it is as yet undeflected, the effects are entirely altered. The deflexion is greater than the same load would produce if gradually applied; for when the beam has reached the point of statical deflexion, the momentum acquired by the downward motion urges it further; and the descent of load continues till it be *brought up* (so to speak) by the increased resistance of the beam. Afterwards, the beam and load rise again, as the deflexion

has been carried beyond the degree at which it can be statically maintained.

In the case here supposed of instantaneous loading, nothing like impact or sudden collision occurs. The pressure at the centre of the beam is finite and continuous. The load does not *fall upon* the beam—it is merely supposed to be placed originally in close contact with the beam, and then suffered to instantaneously rest upon it.

For the sake of elucidation, one or two instances of analogous action may be cited. If a common balance have its fulcrum above the points of suspension of the scales, and a weight suddenly rest in one of the scales, the lever will turn through a much greater angle than if the same weight were applied in small successive portions.

If an elastic string suspend vertically a weight from one end of it, the string will be more stretched if the whole weight be suffered to act at once, than if applied in small portions. It will be found, that if the extension of the string be proportional to the stretching force, the extension produced by the descending weight will be *twice* that due to the gradual effect of the same weight.

A light cylinder of wood, loaded at its lower end, and floating vertically in water, furnishes another illustration. If the cylinder be raised a little above its position of equilibrium and then let go, it will sink twice the distance it has been raised, if the motion be so small that the resistance is equal to the hydrostatical pressure.

In the same way, in a perfectly elastic horizontal beam, loaded at its centre, the effect of instantaneous loading is double that of gradual loading. For, by a known principle of mechanics, when a material system moves from one position of rest to another position of rest, the work done by the retarding forces is equal to the work done by the accelerating forces. For any small deflexion of a beam by instantaneous loading, its position of ultimate deflexion is one of instantaneous rest, for immediately before it arrives at that position, all the parts of the beam descend, and immediately after, ascend. Also, the work done by the accelerating force is the weight actually resting on the beam, multiplied by the space of deflexion: and the work done by the retarding forces is, by what has been said above, "equal to the weight which would statically maintain half the deflexion, multiplied by the whole distance of deflexion." Therefore, putting the two amounts of work done equal to one another, we see that the weight actually upon the beam is that which would statically maintain half the deflexion. In other words, *the deflexion is doubled by instantaneous loading.*

Transit of a Single Weight.

We now proceed to examine the effect of the transit of a single weight *along* the girder, and first of all to show that its effect cannot exceed that which it has just been estimated to produce, if stationed at the centre of the girder and allowed to descend freely from the undeflected position—in other words, it will be proved that at whatever rate the weight may travel over the girder, its ultimate strain and deflexion cannot be more than double the corresponding statical effects produced when it *rests* at the centre of the girder.

There is a general rule of constant use in engineering which, expressed in practical language, states that power is never gained, but only modified, by the intervention of machinery. This rule may be more scientifically expressed and extended by tracing it to its origin—it is a particular case of the principle known in theoretical mechanics, as the Conservation of *Vis Viva*. This principle may be very conveniently enunciated by employing the term "work done," as defined above: and it then assumes this form of enunciation—that the *vis viva* gained or lost by a system in moving from one position to another, is equal to twice the difference between the work done by the accelerating, and that done by the retarding, forces in the same interval.

From this it follows, that where there is no gain or loss of *vis viva*, there is *no* difference between the work done by the accelerating and retarding forces respectively. Hence, if the parts of the system be moving at the same velocity in the second position as in the first—or if both positions be positions of rest—the aggregate work done in the interval by the retarding forces is equal to that done by the accelerating forces.

A very simple case will illustrate this theorem. If a locomotive-engine travel a mile along a railway, and its velocity at the end of the mile be the same as at the beginning of the mile, the work done by all the forces which have resisted its motion is in the aggregate just equal to the horse-power developed in the steam-cylinders. And this equality holds good, however the engine have moved in the interval—whether on a straight level road, or on severe curves and gradients—whether the speed were uniform or very irregular—whether the steam were on the whole time, or the engine during large parts of the journey moved by its momentum only. The intermission of the moving force and all other irregularities disappear in the result. To establish equality between the work done in moving, and that done in retarding, the engine, all that is necessary is that the engine be moving neither faster nor slower at the end of the mile, than at the beginning of it.

Another illustration will serve to show the extreme generality of the principle in question. If a certain quantity of water have to be raised a certain height, the amount of work actually requisite for effecting the object is in all cases equal to the weight of water multiplied by the vertical height. This amount of necessary power or work is incapable of being diminished by any mechanical or hydraulic contrivance. The water may be contained in a vessel which is drawn up perpendicularly, as from a well, or which is drawn up an inclined plane or by a spiral path; or the water may be raised by an Archimedian screw, or by buckets attached to the periphery of a revolving wheel, or by a hydraulic-ram, or by a force pump; or lastly, it may be thrown up in a jet, as from a fountain or fire-engine. But it is physically impossible, by these or any other methods, to diminish the requisite amount of labor. It is, of course, easy to increase the amount by a waste or unprofitable expenditure of labor, such as is caused by friction of the machinery, or the mutual action of the particles of water among themselves. But supposing no waste of force to occur—supposing all the power usefully employed in simply raising the water without doing anything else; then the amount of that power is in all cases

just what has been stated—the weight of water multiplied by the vertical distance through which it is raised.

The rule is of universal application, and there is no other principle of dynamics of such great and constant utility in practical science; for it embraces all those cases of motion with which the engineer happens to be concerned—cases where the motion either ceases, or has the same values, at regularly-recurring intervals.

The case before us, of the transit of a weight along a girder, is a striking exemplification of this Principle of the Conservation of Work. For this principle enables us immediately to compare the effect of a weight moving along the girder, and that of the same weight stationed at its centre, and descending. If the deflexion be the same in both cases, the work done by the descent of the load in both cases is the same—namely, the weight multiplied by the vertical descent: and this is true, whatever be the path of descent. Now, it has already been shown, that in the case of instantaneous loading, the work done by the descent of the weight is equal to that necessary to produce in the beam the deflexion which twice the weight would statically maintain. Hence the traveling weight can do no more.

The value of this conclusion appears the greater; when it is considered that it avoids all hazardous hypotheses as to the forms assumed by the beam during the transit. However the beam may be bent—whatever may be the nature of its vibrations and internal action, this is certain,—that when its elasticity is unimpaired, a weight traveling along it cannot, under any circumstances whatever, more than double its corresponding statical deflexion. To suppose it capable of doing more, is to suppose the physical impossibility of a gain of power.

But though the traveling weight cannot, under any circumstances, produce *more* than double the statical deflexion, it is quite possible that it may do *less*. A large portion of the work done by the weight may be absorbed in producing lateral vibrations and other irregularities of motion in the beam. All these concomitant operations act by way of diminution, and tend to make the dynamical deflexion *less than* double the statical central deflexion.

In determining the actual amount of this diminution, the velocity of transit must be taken into account. For that there is some particular velocity for which the deflexion is a maximum, is obvious from this simple consideration—that when the weight travels exceedingly slowly along the beam, it always exerts a statical pressure, and does not tend to increase by momentum the deflexion beyond its statical amount;—and, on the other hand, when the weight travels with excessive rapidity, it may not have time during the transit, to sink even the distance of statical deflexion.—To take the limiting case, when the velocity is indefinitely great, the descent of the weight must be indefinitely small; for even if it fell freely, and there were no beam to support it, the distance of descent in an indefinitely short time is inappreciable.

Effects of the Inertia of the Beam.

There is, then, between the exceedingly high and the exceedingly low velocity, some particular intermediate speed which produces the greatest

possible deflexion. Before, however, considering what that velocity is, or endeavoring to establish a direct relation between the velocity and the deflexion, it is necessary to examine more particularly the case just referred to—where the velocity of transit is so great, that the weight has not time to sink beyond a certain degree.

Now, there are two ways in which this consideration of time might be supposed to affect the amount of deflexion. The first is that already stated, where the period of transit is so short, that even if the weight descended freely, without support from the beam, its descent would be inconsiderable. This case may, however, be at once excluded, when it is considered that at all practicable railway velocities, the time of transit over a long girder (50 to 80 feet) could not be much less than one second, that a body would fall freely upwards of 16 feet in that time, and that its actual descent (equal to the deflexion of the girder) is only a few inches.

But there is another way in which the consideration of time might be supposed to affect the deflexion: there might not be time enough to overcome the inertia of the beam. This case requires more particular examination.

A person skating over a weak piece of ice may sometimes, by moving rapidly, glide over it safely before it have *time* to break—that is, before the pressure of his body have impressed on the ice the downward motion sufficient for it to attain the point of fracture while he is passing over it. Now, by the general principles of mechanics, the same pressure which, acting for a given time, would produce a great velocity in a small mass, will produce proportionably little velocity in a large mass. In order then that the inertia of the ice may, in the case supposed, be a cause of safety, it must be large in comparison with the pressure acting on it; that is, the mass of ice acted upon must greatly exceed the mass of the man's body.

In the same way, in order that the inertia of a girder might be a cause of security, the mass of the girder must be very much greater than that of the train passing over. But it will be shown that the mass of the former does not, for heavy loads, exceed that of the latter so greatly as to perceptibly diminish the deflexion. It has sometimes been found useful to add to the inertia of the girder by laying on it heavy ballast, and by this means the structure is rendered *steadier*,—that is, the slight lateral oscillations and other irregularities of motion are reduced. But it is only these smaller or subsidiary movements that can be diminished by adding to the weight of the girder. Its mass, and that of the permanent load upon it, is not in general so large as to materially influence the main, or vertical, deflexion, when produced by nearly as heavy a load as it will safely bear.

When the train passes over the girder, the centre of gravity of the whole system sinks, the impressed moving force downwards being the weight of the train, and the motion of the centre of gravity being retarded by the elastic force of the girder.

To take a case every way unfavorable to the conclusion which we wish to establish, let the greatest deflexion be 3 inches, and the velocity of the transit so great that the weight passes over the girder in a second of time. This would be the time of transit over a girder 88 feet long, at the rate of a mile a minute. Now, the extreme deflexion may be supposed to be accomplished in half the time of transit, or the centre of the girder sinks

3 inches in half a second. The centre of gravity of the whole system at no time sinks so much as the centre of the beam sinks, for its two ends do not sink at all. On the whole, it seems an ample allowance to suppose the maximum vertical descent of the centre of gravity of the beam $1\frac{1}{2}$ inch. Now, to find the work which would *alone* prodnce this velocity, we must have an equation of *vis viva*, excluding the retarding force.

By the ordinary rules for calculating the rectilineal motion of bodies, if a given mass M originally at rest be acted upon at its centre of gravity by one uniform force f moving through a space x in the time t,

$$2\,\mathrm{M}x = f\,t^2.$$

Suppose the force to be that of a small weight. The mass of this weight will be found (on substituting numerical values and putting gravity $=32$) to be only the 32d part of M, if the latter move through $1\frac{1}{2}$ inch in half a second.

The beam is usually constructed to bear a pressure considerably exceeding its own weight. In that case *less* than one 32d of the work actually exerted by the traveling weight would suffice for the mere acceleration of the beam: and we come to the conclusion, that even at the highest practicable velocity, the power required to set the beam in motion subtracts very little of the power producing deflexion. In other words, when the mass of the load is not small compared with that of the beam, the deflexion is never materially influenced by the inertia of the beam.

Influence of the Velocity of Transit on the Deflexion in the case of a Single Weight.

Having arrived at the important conclusion that when the traveling weight is large, the inertia of the beam is an immaterial consideration, or that the effective moving forces are inconsiderable compared with the impressed forces, we might suppose the mutual pressure between the beam and the weight statically equal to the force which the former by its elasticity exerts in an upward direction to resist deflexion.

But, in fact, the mutual pressure between the beam and the weight is an unknown force, not generally susceptible of exact determination. During the first part of the motion, the weight does not, so to speak, exert its full pressure on the beam, for the surface yields and recedes before it. During the latter part of the descent, on the contrary, the pressure in question exerts a superior power, to destroy the momentum previously acquired by the descending weight. The weight then moves downwards, first with an accelerated, and subsequently with a retarded, velocity: or the pressure on its under side is in the former stage of motion less, and in the latter stage greater, than the effect of gravity.

The path of the weight is likewise unknown, for the motion is made up of two parts—the motion along the beam, and the motion of the beam itself. If, indeed, it be assumed that the motion is always along the beam, or that at every instant the curvature of the beam has, at the point of mutual contact, the same tangent as the path of the weight, the problem would be capable of solution. The investigations of Professor Mosely and M. Navier have determined the curvature of the beam sufficiently to afford means of tracing the curve described by the moving weight; and

therefore its pressure, which is equal to its centrifugal force + the effect of gravity, might be ascertained.

The hypothesis which would lead to these results is, however, arbitrary and unsafe: and besides, the curvature of the beam as mathematically determined, is not exactly that which occurs in actual practice, where the elasticity is always more or less imperfect. The difficulty is however of no great importance, because, as will be presently shown, it does not occur where the moving body is not a single weight, but a long train. And the subject is here referred to, merely to show the almost insuperable difficulties of determining the motion of a single weight along an elastic beam.

(TO BE CONTINUED.)

Railway Accidents in Great Britain and Ireland.

By an Analysis of the Returns made to the Railway Department, it appears that of the 90 persons killed and 99 injured, on all the Railways open for public traffic in Great Britain and Ireland, during the half-year ending the 30th June, 1848, there were—

6 Passengers killed, and	60 injured from causes beyond their own control.
5 Passengers killed, and	2 injured, owing to their own misconduct or want of caution.
7 Servants of Companies or of Contractors killed, and	14 injured from causes beyond their own control.
52 Servants of Companies or of Contractors killed, and	18 injured, owing to their own misconduct or want of caution.
18 Trespassers and other persons, neither Passengers nor Servants killed, and	5 injured by improperly crossing or standing on the railway.
1 person run over and killed, at a crossing, through misconduct of an engine-driver.	
1 suicide.	
90 killed.	99 injured.

And for the same period the number of passengers amounted to 26,330,492.

Application of Air to the Brakes of Railway Carriages.

Mr. Samuel Cunliffe Lister, of Manningham Hall, Bradford, has taken out a patent for so applying air, either by compression or by exhaustion, as to act upon the wheels of railway carriages simultaneously as a powerful break. To each carriage is to be attached an air-reservoir, or tank, of sufficient strength to sustain a pressure of 50 to 60 lbs. on the square inch. This reservoir, or tank, will be charged with compressed air, or exhausted of air, by means of an air-pump, actuated in any convenient manner. In connexion with each tank a pipe communicates with a main

pipe, extending beneath the frame-work of each carriage lengthwise, and midway between the wheels. From each side of this main-pipe there extend branch pipes, communicating with cylinders, suitably fixed between each pair of wheels at the side of the carriage: each cylinder is fitted with two pistons, working air-tight, and piston-rods, furnished with break-blocks. Instead of the middle of the block being in a line with the centre of the axle, however, the bottom of the block is in a line with it. Now assuming the pressure of the compressed air in the main tube, or pipe, when filled, to be 5 lbs. on each square inch of the piston, and each piston to present a surface of the area of 200 square inches, there will be a force of 1000 lbs. exerted upon each piston, pressing the brake blocks against the peripheries of the wheels: and this pressure will take place simultaneously in all carriages comprising a train, upon the guard opening a valve for admitting the compressed air to pass from the reservoir, or tank, into the main pipe, by which the impetus of the train will be suddenly checked. Instead of employing compressed air, a vacuum may be formed in the main tube, and the pressure of the atmosphere be allowed to exert itself upon the other side of the piston—the end of the cylinder being left open for that purpose. Lond. Builder, Aug. 1846.

A New Turn-table, for Railways.

A new turn-table, on an improved principle, has been invented by Mr. Turiff, one of the proprietors of the Vulcan Foundry, at Paisley. The *Ayr Observer*, in describing it, says: "The engine and tender, which weighed 36 tons, were placed on the turn-table: and two men turned it, by means of two wheel-pulleys, with comparative ease, in the most incredibly short time of about a minute and a half. There was not the slightest jar while the movement was proceeding: on the contrary, the carriages rested on the table as softly as if they had been on cushions. The great advantage of this invention of Mr. Turiff's is, that with former turn-tables there were two frictions, while with this table there is only one: it is relieved by a powerful weight resting in the centre, which contains four large bolts that lift the table from the side-rails beneath. The machinery, like all inventions of practical use, is very simple, but composed of massive beams of iron, and can be worked by circular rollers in cases of emergency. The turn-table itself is 36 feet in diameter, weighs 25 tons, and sustains 51 tons revolving weight." Ibid.

The Bridge over the New Cut on the Northern Railway.

The bridge over the New Cut on the Northern Railway (near Doncaster) will consist of two brick piers—one on each side—with stone quoins, built upon piles, sunk four feet below the natural surface of the stream. From these piers will be thrown cast metal circular tubes, instead of the usually solid girders, and upon the tubes the permanent way will be laid. At present the foundation of the south pier only has been laid, but as all the piles for the other have been driven, not a long time will elapse before

it is commenced. Mr. Moody is the sub-contractor for this and the other bridges. Ibid. Oct.

Abuse of the Arch.

If we now leave its origin, and say a few words on its application, we may observe the arch is, of course, very useful in certain places, but when misapplied, is not only useless, but dangerous, as nine out of ten of the corner houses of the streets of London can testify: indeed, the thrusting of the arch, with the expansion and contraction of materials, pushes out what it can never recover; and when the lateral bonding is not sufficient to restrain the arch, sooner or later the building becomes bulged, and its strength impaired; so that the more we revert to the old Greek system of lateral girders and vertical pressure, the greater stability we shall have in our buildings. Ibid.

The Conservatory at Chatsworth.

This immense structure is composed of glass panes manufactured especially for it, placed in iron framework, of the lightest apparent kind, but as subsequent trials have proved, of the most firm and substantial description. The length of the erection is nearly 300 feet, its height above 70, and its width 150. It covers nearly an acre of ground, through the centre of which is the carriage road, and the tubes for the hot water which regulate the required temperature measure six miles. A light, but beautiful, gallery, erected at the base of the dome, and which traverses the entire building, enables the spectator to review the whole of the interior from various points. The access to the gallery is by steps, placed with admirable taste in the midst of rock work, in the fissures of which are plants, apparently natural productions. A tunnel surrounds the whole edifice, by which access is obtained to the stoves and pipes, and rails are laid down to convey the coals per train, and supply the necessary heat. The interior contains a vast number of trees and plants, many of them of gigantic proportions, and the rarest of tropical growth. Birds of varied and exquisite beauty, whose delicate structure could not endure the rigors of our climate, are seen flying about; and pools of water, in which plants suited to the required purpose have been encouraged to grow, contain gold, silver, and other fish. In this structure may be seen the largest crystal yet found in the world; and also one, but of much smaller dimensions, which has been pronounced the most beautiful.—*Derbyshire Courier.* Ibid.

Viaduct across the Dee.

We feel pleased to have it in our power to notice one of the most daring and stupendous efforts of skill and art to which the railway has given rise. We refer to the great viaduct now in course of completion across the valley of the Dee, in the vale of Llangollen, the dimensions of which sur-

pass anything of the kind in the world. Its vastness of proportions may be better conceived when it is stated that in magnitude it far exceeds what is considered the greatest effort of human skill in connexion with railway communication—the Stockport viaduct. The Dee viaduct is upwards of 150 feet above the level of the river—being 30 feet higher than the Stockport viaduct and 34 feet higher than the Menai Bridge. It is supported by 19 arches of 90-feet span, and its length is upwards of 1530 feet, or nearly one-third of a mile. The outline of the structure is perhaps one of the handsomest that could have been conceived, both as regards its chaste style and attractive finish, and its general appearance is considerably enhanced by the roundness of the arches, which are enriched by massive coins, and the curvilinear batter of the piers. This style of architecture imparts a grace and beauty to the structure without impairing its strength. The greatest attention seems to have been paid to the abutments—the only part of the erection, in reality, where any decorative display could be made. In the middle of both, on each side, there are beautifully executed niches in the Corinthian order, in addition to some highly finished masonry.—With the exception of the intrados of the arches, which are composed of a blue sort of brick, the whole structure is built of beautiful stone, if not as durable, equal in richness and brilliancy to Darlydale. The viaduct has an inclination from end to end of 10 feet, and connects that part of the Shrewsbury and Chester Railway between Rhos-y-Medre and Chirk. It has been erected by Messrs. Makin, Mackenzie, & Brassy, contractors, at a cost of upwards of £100,000, being upwards of £30,000 more than the Stockport viaduct. The cost of the timber required to form scaffolding, &c., for its erection was £15,000, and between 300 and 400 masons alone were employed during the whole time of construction.—*Liverpool Mercury.*

London Athenæum.

AMERICAN PATENTS.

List of American Patents which issued in the month of December, 1847, *with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents, in the U. S. Patent Office.*

1. For an *Improvement in Gauges used in Finishing Spiral Hand Rails;* Curtis Wooster, Philadelphia, Pennsylvania, December 4.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the spiral tongued or grooved post, in combination with the arm and its gauge points, for the construction of the ways and hand rails of spiral stairs, as set forth."

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2. For *Improvements in Self-acting Cheese Presses;* Elias Hall, Persia, Cattaraugus county, New York, December 4.

Claim.—"What I claim as new, and desire to secure by letters patent, is the combination and arrangement of the vertical rack bars, to which

the cross-heads are connected, with the suspension and self-operating pinions on the axle, in the manner substantially as set forth."

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3. For an *Improvement in Registers for Furnaces;* George Pollock, City of New York, December 4.

The patentee says,—"My improvement consists in hanging the valves on journals in the middle, so that each valve shall be balanced, or nearly so, when this is combined with the arrangement for opening and closing them, which consists in having two pins projecting from the upper surface of each valve, and perpendicular thereto, and acted upon by a cam-formed rim attached to the vertical spindle, this rim being so formed that as it recedes from the axis of the spindle, it rises to a plane oblique to the axis. By this arrangement the cam rims are embraced by their appropriate sets of pins, so that when the spindle is turned in the direction from the point of the greatest diameter of the cam rim toward the shortest diameter, the two valves are turned from a plane at right angles, or nearly so, with the spindle, to a plane parallel therewith, and vice versa."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is hanging the valves, or journals, in the middle of the width to be balanced, substantially as described, when this is combined with the cam-formed and oblique or curved rims, by means of the pins projecting from the surface of the valves, and at right angles thereto, or nearly so, as set forth."

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4. For an *Improvement in Decomposing Alkalies and other Salts;* R. A. Tilghman, Philadelphia, Pennsylvania, December 4.

The patentee says,—"My invention consists in a method of decomposing the sulphates and muriates of the alkalies and alkaline earths, by exposing them at a high temperature to a current of steam, or vapor of water, by which the acid is carried off, and the alkaline base either remains free, or enters into combination with some third substance, provided for that purpose."

Claim.—"I claim as my invention, the decomposing the sulphates of baryta, strontia, lime, and magnesia, and the muriates of baryta, strontia, and lime, by exposing them at a high temperature to the action of a current of steam, for the purpose of obtaining the acids and the alkalies of these salts respectively. I also claim the decomposing the sulphates and muriates of potash and soda, for the purpose of obtaining the acids and the alkalies of these salts respectively, by exposing them at a high temperature to the action of a current of steam, alumina or other combining substance being present. I also claim making aluminates of potash and soda, by the action of a current of steam upon a mixture of alumina and the sulphate or muriate of potash or soda, at a high red heat. I also claim the making sulphate of soda by the action of a current of steam upon the muriate of soda at a red heat, sulphate of lime being present, as described."

5. For an *Improvement in Decomposing Potash Felspar for obtaining certain salts;* R. A. Tilghman, Philadelphia, Pennsylvania, December 4.

The patentee says,—"My invention consists in a method of decomposing felspars containing potash, by heating them with a sulphate or muriate of another base, by which means are produced a sulphate or muriate of potash, and a silicate of the other base employed."

Claim.—"I claim as my invention, the method of decomposing potash felspars for the production of sulphate of potash, by heating at or above redness, a mixture of potash felspar, and the sulphate of either lime, baryta, or strontia. I also claim the method of decomposing potash felspars for the production of muriate of potash, by heating together a potash felspars and the muriate of either soda, lime, or iron, at a temperature above the melting point of the muriate employed."

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6. For an *Improvement in Connecting Rods, Pitmans, &c.;* Reuben Curnutt, Georgetown, Pettis county, Missouri, December 4.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is a pitman, or connecting rod, composed of several parts jointed together, in combination with the braces for controlling their motions, the whole constructed as set forth."

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7. For an *Improvement in Brick Presses;* Nathan Sawyer, Baltimore, Maryland, December 4.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, first, the construction of the pulverizer, as set forth, it being a cylinder with teeth working between, and projecting above grate bars, as a means of preventing stones or other hard substance from passing through into the machine below.

"I claim the method substantially as described, of pressing the bricks by the downward and upward pressure of the pistons, and retaining their pressure until the bricks are elevated above the bed, in combination with the method of elevating the two sets of pistons, while the pressure is retained on the bricks, as described.

"Third, I claim the method, substantially as described, of preventing the sudden separation of the upper pistons from the surface of the bricks, by the interposition of springs, or their equivalents, between the pistons and that part of the machinery by which they are elevated. The cross head may be used without this movable piston, by permitting it to have a slight movement on the columns, and the spring being placed on the top of the cross head will also effect the object—a lever and weight applied in the place of a spring might also be used to some advantage."

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8. For an *Improvement in Bedstead Fastenings;* George B. Nash, Kingsbury, Washington county, New York, December 4.

The patentee says,—"The nature of my invention and improvement consists in uniting the posts and rails of bedsteads, by means of mortised cylinders made with stops, or projections, and secured in the posts, and

sliding tenon with heads let into the ends of the rails where they are made fast by an eccentric pin—the head being inserted through the mortise in the fixed cylinder."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the cylinder with the sliding tenon and eccentric pin, constructed, arranged, and operated, in the manner and for the purpose set forth."

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9. For an *Improvement in the Construction of Boats and other Vessels*; Joseph Tuers, Jersey City, New Jersey, December 4.

The patentee says,—"The nature of my improvement consists in forming a boat with a single bow, from which diverge two keels, the triangular space between said keels being occupied by an inclined plane that extends from a point just in the rear of the bow, backward, and upward to the transom, where it terminates, and at which point it is as broad as the space between the keels; by which means I obtain a boat possessing in all essential particulars, the advantage of a double or turn boat, and obviate many of its prominent defects."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of a single bow with two diverging keels, as set forth, and in combination therewith, the inclined centre plane, as specified."

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10. For an *Improvement in Machinery for Making Sheet Iron, &c.;* A. W. Whitney, Woodstock, Windsor county, Vermont, December 11.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the rocking box, the collar, and set screw, and the spiral groove with the two shafts and circular dies, arranged and connected as described. I also claim the combination of the sector ratch and spring latch, with the guide roller, in the manner and for the purpose set forth."

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11. For an *Improvement in Sofa Tables;* Cornelius Briggs, Roxbury, Norfolk county, Massachusetts, December 11.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the new article of furniture herein described and denominated a "sofa table," and which is formed by making a sofa with a turning back, and a seat susceptible of division, all substantially as set forth."

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12. For an *Improvement in Kilns for Drying Grain;* Nathaniel F. Potter, Providence, Rhode Island, December 11.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the manner set forth of arranging any number of double partitions, formed by sheets of wire gauze, perforated metal, or other suitable material, through which heated air is allowed to ascend; in combination with similar spaces, through which the material to be dried is allowed to descend, under an arrangement of parts substantially the same with that set forth. I claim also the alternately arresting, and allowing the descent

of the grain through the spaces between the double partitions; this being effected by means of valves made to operate in the manner and for the purpose set forth."

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13. For an *Improvement in Regulators for Machinery;* Leman B. Pitcher, Syracuse, Onondaga county, New York, December 11.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the pump, or pumps, chamber, piston, or float, rod, escape cock, or any analogous arrangement, with the machinery to be regulated, or with the power by which such machinery is driven, for the purpose of regulating said power, or the motion of the machinery, substantially as set forth."

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14. For an *Improvement in the Apparatus for Club-foot;* E. K. Chamberlain, Cincinnati, Ohio, December 11.

The patentee says,—"The nature of my invention is a ball and socket joint apparatus, which consists of leg and thigh pieces, composed of thin copper, brass, iron, or any malleable metallic plate, fitted according to the limb, lined with buckskin or cloth, and padded, which pieces are connected at the knee with metallic joints."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of the ball and socket, or universal joint, to club-foot apparatus, including the improved sandale, with a joint in its centre, moved by a screw attached at each of its ends, as set forth."

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15. For an *Improvement in Sawing Warped or Curved Surfaces;* John W. Cochran, City of New York, December 11.

The patentee says,—"My said invention consists in certain additions to, and variations in, the construction and arrangement of the various parts of machinery used for sawing or cutting wood, so as to prepare the same of such shapes as may be required for ship building and other purposes."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is,—

"Firstly, The mode of constructing saw mills, or machinery with revolving or turning chuck plates, and oscillating or turning intermediate roller supports, for the purpose of holding, sustaining, or supporting, logs, or pieces, of timber, whilst being cut; such chuck plates and supports being made capable of being turned by the machine itself, or by hand, for the purpose of varying (when necessary) the bevels of the cuts to be made by the mills or machines, for the purpose of producing pieces of timber of the required shapes.

"Secondly, The mode of giving the motions to determine the curves and move the supports of saw mills, as aforesaid, by means of a pair of conical drums connected by belts or bands, and furnished with graduated scales for the purpose of enabling the attendant workman to regulate the motions of the parts that hold and support the pieces of timber, so that the bevels or curves of the cuts to be made in such pieces of timber, may

be varied in the manner necessary for cutting such pieces into the regular shape.

"Third, The mode of constructing such chuck plates as aforesaid, with the jaws or clips thereof mounted upon an eccentric motion: that is to say, upon a foot or piece fitted into a groove, so as to be capable of sliding laterally therein from the centre of the chuck plate, for the purpose of bringing the centres of gravity of logs, or pieces of wood of irregular shapes, within a centre line drawn between the centres of the chuck plates, for the balancing of such logs or pieces of wood, whilst they are being cut or shaped in the mill.

"Fourth, The mode of constructing the jaws or clips of such chuck plates as aforesaid, with quadrant slots, and so that one of the jaws or clips thereof may be turned towards either side, for the purpose of better and more securely holding logs or pieces of wood of crooked or irregular forms, whilst being cut or shaped in the mill as described.

"Fifth, The mode of mounting saws in stretchers as described, in combination with the mode of mounting such saws with their stretchers within a saw gate or frame, so as to be capable of sliding laterally in either direction within the saw gate or frame."

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16. For an *Improvement in Abdominal Supporters;* John W. Hood, Mount Sterling, Montgomery county, Kentucky, December 11.

The patentee says,—"The nature of my invention consists principally in the peculiar formation of the spring, which passes around the body in exact accordance with the form of the pelvic bones, and in the arrangement and form of the elliptical pads attached to its inguinal portions, which are in the form of the inguinal regions, giving the wanted support to those parts in the most effectual manner; for the form of the pads is such, that the power of the rectus abdominis muscle to displace the instrument, in reaching up or lifting, is entirely overcome."

Claim.—"What I claim as new, and desire to secure by letters patent, is the particular form given to the spring, in combination with the padding, whereby it is adapted to the support of the inguinal region, for the purpose of preventing the descent of the organs which would otherwise tend to press upon the womb, and which are, in fact, the principal causes of the displacement thereof; and by the particular form given to the instrument, all the muscles that are themselves liable to misplace the said instrument, are avoided; and, in combination with the foregoing, I claim the manner of combining and arranging the back pads, so as to cause them to press upon the ilium as set forth; and it is hereby to be distinctly understood, that I do not, by this claim, intend to limit myself to the precise form and dimensions of the instrument, but to vary these as may be deemed expedient, substantially as set forth."

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17. For an *Improvement in Dragoon Saddle Trees*; Thornton Grimsley, St. Louis, Missouri, December 11.

The patentee says,—"The nature of my invention consists of an improvement upon the form of the pommel and cantle, made use of in the con-

struction of the French, or old dragoon regulation saddle tree, and in the combination, without metallic fastenings, of the French huzzar, or dragoon regulation style of pommel and cantle, or my improved form of pommel and cantle, with winding side bars, of such a form, and arranged in such a manner, that they will bear so equally and uniformly in every part, upon the back of a horse or mule, as to require no padding. The French huzzar saddle tree has straight side bars, which do not fit the back of the horse with accuracy, and in consequence, it is necessary that they should be padded to prevent injury to the horse. I secure the pommel and cantle to the side bars of my military saddle tree by means of a raw hide covering, confined in the manner set forth, by which means my tree is much lighter and stronger than the French huzzar tree."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the form of my improved side bars, the under side of which are adapted to the form of a horse, and the upper side and edges to the seat of the rider, and the combining and securing the same to a high pommel and cantle, by means of a raw hide covering, substantially as set forth."

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18. For an *Improvement in Cheese Presses;* C. B. & J. Kingsbury, Utica, New York, December 18.

Claim.—"What we claim as our invention, and desire to secure by letters patent, is the making the press self-acting, by means of the racks and pinions of different sizes, operating upon the separate frames.

"Secondly, We claim the oblique rack and levers, in combination with the lower frame and wheel."

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19. For an *Improvement in Machinery for Grinding Knives which have warped surfaces;* Wm. Hovey, Worcester, Massachusetts, December 18.

The patentee says,—"My present invention consists in arranging the grinder so that it shall receive, in addition to its rotary, a reciprocating motion in the line of its axis, to pass its surface over that portion of the knives attached to a stock, and held in appropriate boxes, or between centres, in a carriage which moves from end to end, under the grinder, and at right angles to its axis; the knife which is under the operation of the grinder, being supported by a bed or gauge plate, which insures the grinding of the edge of each knife, to the same distance from the axis of the stock to which they are attached."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of the grinding wheel, so mechanically arranged that, while the grinder is made to revolve longitudinally on the edge of the knife, it receives at the same time a lateral reciprocating motion on its own axis, which is at right angles with the line of the edge of the knife on the cylinder, or nearly so; in combination with the top and bottom traversing carriages and the gauge rest, constructed substantially as set forth."

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20. For an *Improvement in Rolling and Compressing Puddlers' Balls;* John F. Winslow, Troy, Rennselaer county, New York, December 18.

The patentee says,—"The nature of the first part of my invention consists

in rolling and compressing puddlers' balls, or loups of iron, into blooms, &c., by means of a rotating cam-formed compressor, combined with two or more rollers, placed near to one another, and at the same distance from the axis of motion of the compressor, so that the compression and elongation of the loup will be due entirely to the eccentricity of the compressor; the whole being so geared that the rollers shall turn in the direction opposite to the motion of the compressor, that the loup may be rotated and retained between the rollers and the compressor. The surfaces of the rollers are formed with slight projections, to take hold of and turn the loup of iron, and the surface of the cam-formed compressor with teeth, which are very large at first, or on that part of the compressor which first acts on the loup, to squeeze out the impurities, and at the same time insure the turning of the loup, and then gradually diminished, until the surface becomes quite or nearly smooth, to finish the bloom.

"And the second part of my invention consists in combining with the compressor and roller two cheeks, one on each side, and provided with springs that force them towards one another, that they may yield to the ends of the loup of iron, as it is lengthened out by the action of the compressor and rollers, and at the same time to make sufficient resistance to give a proper form to the ends of the bloom, &c.

"And the third part of my invention consists in combining with the compressor and rollers, a feeder or sliding frame, operated by a projection on the compressor or the shaft thereof, to carry in the ball of iron between the compressor and the rollers, as that part of the compressor which is recessed for this purpose comes around to the proper place for the introduction of the ball, and the discharge of the bloom. And also in combining in like manner a follower, for discharging the bloom after it has been completed."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method described, of compressing or shingling puddlers' balls or loups of iron into blooms, by the combination of the cam-formed compressor and two or more rollers, substantially as described.

"Secondly, I claim the spring or yielding cheeks, for setting up the ends of the blooms, in combination with the combined cam-formed compressor and rollers, substantially as described.

"And finally, I claim the feeder and discharging follower, in combination with the combined cam-formed compressor and rollers, for the purpose and in the manner set forth."

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21. For an *Improvement in Galvanic Batteries for Telegraphs;* L. B. Swan, Rochester, Monroe county, New York, December 18.

Claim.—"What I claim as new, and desire to secure by letters patent, is the use of the within-named solution when applied to the batteries of the electro-magnetic telegraph; said solution consisting of dilute sulphuric acid, kept saturated by an alkaline sulphate, for the purpose and in the manner herein fully made known. In the foregoing specification and claim I have, as it will be seen, limited my claim to the use of my solution in batteries used for telegraphic purposes, and this I have done, that I may

not be supposed in any way to interfere with experiments having for their object the advancement of science."

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22. For an *Improvement in Pumps for Raising Water;* G. Ketchum, Marshall, Calhoun county, Michigan, December 18.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the tubular plunger, having valves combined with each end, and a series of apertures in its central portion, combined and operating with the pump cylinder, side pipe, water chamber, and discharging chamber, substantially in the manner set forth. I also claim the manner of packing the tubular plunger, by means of the annular ledge on the inner surface of the pump cylinder, the leather or other suitable rings, and metallic tubes, combined and operating substantially as set forth. I also claim the combination of my improved double-acting submerged forcing pump, with an enclosing casing, for the purpose of converting the same into a suction and force pump, substantially as set forth."

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23. For an *Improvement in Muzzles of Rifles;* John H. Rector, Syracuse, Onondaga county, New York, December 18.

The patentee says,—"The nature of my invention consists in adapting, accurately fitting, and securing, a movable creased muzzle piece to rifled guns, in such a manner that it can be easily removed, and quickly and securely replaced again upon the same, for the purpose of protecting the bore of the rifle from the injurious effects of friction in loading, the muzzle piece to remain in the rifle barrel in hunting and ordinary shooting, and removed when great accuracy of shot is desired."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the adapting, accurately fitting, and securing, a movable protecting muzzle piece to the end of the bore of a rifle, or creased gun, in such a manner that it can be easily and quickly removed for firing, and as readily replaced and secured for re-loading the rifle, by means of the guiding grooves, knobs, the longitudinal grooves connected to the lateral inclined grooves, the sliding bolts, the slots, the springs, with the curved central slots, combined with each other, and operating substantially as set forth."

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24. For an *Improvement in Disinfecting Compounds;* Jean Le Doyen, Paris, France, December 24.

The patentee says,—"The nature of my invention consists in the application of a liquid composed of nitric acid and cerlise, or carbonate of lead, and water, to the purposes of disinfecting, &c."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the use of the described preparation or composition, for disinfecting animal substances, and other matters, fœtid gases, and impure places."

25. For an *Improvement in Cleaning Filters;* John Watson, Kingston, Jamaica, December 28.

The patentee says,—"The improvement consists in the application of a vertical brush, connected at top and bottom to an upright shaft, by horizontal arms."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the use of the brush or scraper, in combination with a filter, for the manufacture of sugar, and for other purposes, the whole being combined and operating substantially as set forth."

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26. For an *Improvement in Paddle Wheels;* E. J. McCarthy, Saugerties, Ulster county, New York, December 28.

The patentee says,—"The nature of my invention consists in so regulating the movement of a bucket, relatively to the wheel, as that it shall enter the water radially, or nearly so, and as it rises from the water, allowing its point to fall back, so as to relieve it from the lift the common radial paddle is subject to at that point, the action being produced without any strain on the parts that allow the movement."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the construction and arrangement of the apparatus for moving the paddles, substantially as described, consisting of a sliding bar, moved by an eccentric that is connected, by means of a stud, with a slit in the jointed brace to which the paddle is affixed, so as to cause the paddles to enter the water radially, and thus remain to the centre of their action, and then to fall back into an inclined position and leave the water freely—the action of the paddles aiding the change."

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27. For an *Improvement in Fences;* W. G. Brainard, Hamilton, Madison county, New York, December 28.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of the lever and fulcrum principle, in building and supporting on the surface of the ground, post and bar or rail fence, as described; the said principle to be applied in the following manner:—After fastening the first post permanently, insert in the mortises of said post any desired number of bars or rails, say from three to six; then place a second post on the opposite ends of the bars or rails, carrying said second post, with bars inserted, round in a perpendicular position, say to the right of the intended line of fence, so far as to make the bars operate as levers on the first post. Then insert a second set of bars or rails in the same mortises with the first set of bars, the tenons of one set above the others in the second post, placing a third post on the opposite ends of the second set of bars, carrying the third post to the left of said intended line, to such an angle as to make the second set of bars operate as levers on the second post; proceeding in the same manner, carrying each succeeding post, with bars inserted, each way from the intended line of fence, far enough to bind the bars and posts firmly together, supporting each set of rails, together with the posts, firmly in their perpendicular position, fastening the last post as the first, firmly in its place; all the other posts being placed on the surface of the ground."

28. For an *Improvement in Fences;* Thomas J. Hubbard, Hamilton, Madison county, New York, December 28.

The patentee says,—"The nature of my invention consists in securing the corners of the key fence with keys of a mitre or three-cornered form, the fence being made of sawed rails, and laid up edgewise into an angular or worm fence; two of which keys are required at each angle, and when adjusted, firmly securing the corners of the fence."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the securing the corners of a field fence constructed of sawed rails, by means of keys of a mitre or bevel form, applied in the way and manner described."

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29. For an *Improvement in Harness Saddles;* A. D. Brown, City of New York, December 28.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combining the clamp pieces with the housing plate, for the purpose of securing the pad leather to the same, and causing the housing plate to form the upper side of the pad, substantially in the manner set forth. I also claim the manner of combining the housing leather with the plate, by means of the vertical flanches, the terrets, and screws, as set forth."

List of American Patents which issued in the month of January, 1848, *with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents, in the U. S. Patent Office.*

1. For an *Improvement in Purifying Liquids by Galvanism;* Andrew Crosse, Broomfield, Somerset county, England, January 6.

The patentee says,—"My invention consists in applying electric currents to act on fermentable, fermented, or other liquids, from which it is desired to extract or precipitate impurities or matters."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the mode substantially described, of applying electric action to extract or separate impurities or matters, from fermentable, fermented, or other liquids."

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2. For an *Improvement in Winnowing Machines;* John Thurston, Bath, Franklin county, Indiana, January 6.

The patentee says,—"The nature of my improvement consists, first, in constructing the feeder that receives the grain, with three or more successive steps, composed of slats of wood, with openings between each one, which peculiar construction assists in feeding, by the blast created by the fan, being forced through said openings, and driving off the loose straw, &c., which tends to obstruct the passage of the grain; and second, in giving a vertical motion or shake to the feeder, and riddle attached thereto, by means of arms that are operated on by the shaft of the fan, said arms

extending from the shaft, and bearing up against the lower side of said riddle."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is forming the feeder of slats of wood, one below the other, with openings between them, for the purpose of facilitating the feeding operation, in the manner set forth. I also claim, in connexion with the above, the vertical motion given to said feeder and the upper riddle, by means of the long arms acted upon by the shaft of the fan, as set forth."

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3. For an *Improvement in Machines for Threshing and Cleaning Clover Seed;* Elias Grover and John Gilliford, Juniata county, Pennsylvania, January 12.

Claim.—"What we claim as our invention, and desire to secure by letters patent, is the combination and arrangement of the crank, the knob, the blocks, and the springs, in the cleaner as set forth."

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4. For an *Improvement in Boot Crimps;* Cosmon White, Galway, Saratoga county, New York, January 12.

The patentee says,—"The nature of my invention consists in connecting the jaws to the end of the lever for operating the same, by two slightly inclined bars, for connecting rods, attached at their upper ends to the jaws, and at their lower ends to the lever, by pins or bolts, having oblong slots formed in them, through which is passed a horizontal bolt, which is also passed through the end of a curved bar or dog, extending downwards between the inclined bars, and through two oblong metallic plates, pressed against the outsides of the slotted bars by a head and thumb, or hand nut, at the extremities of the bolt, in such a manner as that, when motion is given to the lever, and the upper edges of the jaws commence to crimp the leather, the upper end of the curved bar or dog will strike the lower edge of a curved form or bar forming part of the frame, and arrest the progress of the bolt and plates, while the jaws will be allowed to proceed, and be forced over the boot leather, and being kept the same distance from the crimp by the plates and bolt, will exert the same degree of pressure at every point. Secondly, In connecting the extremities of the jaws together, by projections or cogs cast on the inner sides of one jaw, and extending through vertical slots in the frame, into mortises formed in the extremities of the jaw on the opposite side; thus not only performing the office of guides for the jaws, during their up and down movement, but also connecting the two together. Likewise in casting a guide arm on the cogged jaw, for moving up and down in one of the mortises in the frame for guiding the jaws, during the operation of crimping."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, First, The method of preserving the parallelism of the inner sides of the jaws with the outer sides of the tapered crimp board, during the operation of raising and lowering the jaws for crimping the upper, by which a uniform and equal pressure is produced upon the leather by means of the aforesaid combination and arrangement of the dog, screw, and plates, with the slotted bars and curved jaws, operating in the manner and for

the purpose set forth, the said dog being free to play up and down loosely between the form and base of the frame.

"2d. I also claim interlocking the ends of the jaws by means of the cogs and mortises, in combination with the oblong mortises in the frame, in which the cogs rise and fall during the operation of the jaws as described.

"3d. I further claim the manner of connecting the shutter to the plates, by means of the socket joint as described.

"4th. I also claim making the frame with a curved form the shape of the lower edge of the crimp board, upon which the leather to be crimped is first placed, preparatory to its being pressed over the crimp board."

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5. For an *Improvement in Hanging Carriage Bodies;* S. Fairchild, Trumbull, Fairfield county, Connecticut, January 18.

The patentee says,—"The nature of my invention consists in the application of stays or spring braces, in combination with semi or reverse elliptic springs, extending from one axletree to the other, in constructing the running gear of carriages, and in attaching the springs and stays firmly to the axletrees, both operating and expanding together, thus dispensing with the common elliptic spring and perch."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is connecting the back axle with the front one, and with the bear, by means of the reverse elliptic springs and stays which sustain the body of the carriage; thus dispensing with the usual perch and elliptic springs, and diminishing the expense of the carriage, and rendering its action easier, as set forth."

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6. For an *Improvement in Folding Shower Baths;* George Woods, Boston, Suffolk county, Massachusetts, January 18.

The patentee says,—"My improvement consists in such an arrangement of the sides and bottom and showering pan, that they may be folded up, as it were, when the apparatus is not in use, and thereby occupy a space only about eight or ten inches in width from the wall against which the back of the bath may be set."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is a portable shower bath, constructed so as to fold up and occupy a small space: that is to say, by having the showering pan and foot bason so hinged as to turn up vertically when not in use, and the two sides so hinged as to close in upon the same, while the door closes upon the whole as set forth."

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7. For an *Improvement in Cooking Stoves;* William Jackson, Syracuse, Onondaga county, New York, January 18.

Claim.—"What I claim as new, and desire to secure by letters patent, is the combination of the return flues, passing through the oven, with the hearth plate, forming the top of the oven, (there being sufficient space between the hearth plate and the upper surface of the flues for the free circulation and diffusion of heat,) substantially as set forth."

8. For an *Improvement in Spinning Frames;* Wanton Rouse, Thompson, Windham county, Connecticut, January 25.

Claim.—"What I claim as my invention, is governing the winding of the thread in forming the cop, so that it shall bind in its descent, by means of the regulator with the drop or fall, in combination with an eccentric curve or periphery as set forth."

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9. For an *Improvement in Making Hoes;* John Abbott, Boston, Massachusetts, January 25.

The patentee says,—"The nature of my invention consists in preparing the plate of the hoe, by punching a hole of suitable dimensions to receive the socket and handle, around which are three or more small holes, for the passage of the metal of which the eye is composed from one flanch to the other. I then take the plate and place it in a flask or mould constructed with two jaws, the one in the cope and the other in the nowel of the flask, which, when the flask is closed upon the plate, holds it around the eye firmly like a vise, leaving the plate outside the jaws free to spring, when expanded by the heated metal."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the casting of hoe eyes or sockets upon the plates, by means of moulds or flasks, so constructed as to hold the plate firmly around the eye as set forth."

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10. For an *Improvement in Hot Water Apparatus for Heating Buildings;* Anthony E. Hitchings, City of New York, January 25.

The patentee says,—"The nature of my invention consists in providing a series of double cylinders, connected together first at top and then at bottom, and both ends of the series with a boiler, so that the water heated in the boiler shall ascend in the space between the two first cylinders, down between the second set, then up between the third set, and so on to the end, and then delivered to the boiler, the circulating force given to the boiler by heat being sufficient to enable it to ascend and descend more than once;—each set of double pipes or cylinders is thus constituted a heater, that radiates heat from the two surfaces; instead of making these round, they may be of any other form. To prevent accident from overheating of the water, and to keep it at its proper level, I have applied a ball cock and waste pipe to the reservoir."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the plan of radiating heat by hot water, which circulates from a boiler and back to it, and in its circuit passes up and down two or more times through a series of heaters, each consisting of two tubes, one within the other, the water passing between the two, that the outer and inner surfaces of the heaters may radiate heat, and these being so combined as to receive the water from the boiler at one end of the series, while the other end gives it out to the boiler, and the series of heaters being so connected as to require the water to ascend, descend the second, ascend in the third, and so on through the series, by the connexion of the two ends of the series with the boiler, substantially as set forth."

11. For an *Improvement in the Manufacture of Prussiates of Potash and Soda;* Martin Kalbfleisch, Bushwick, New York, January 25.

The patentee says,—"The nature of my invention consists in dissolving animal matters of any kind in caustic potash or soda, and drying the same before to a strong heat or calcination."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the dissolving the animal matters in caustic potash or soda, thereby rendering the union of the materials more intimate and perfect than by any other mode in use."

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12. For an *Improvement in Machines for Rubbing Types;* James L. Duncan, City of New York, January 25.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is my peculiar mode of rubbing and smoothing type, by means of the combination of the stationary adjustable cutters, revolving feed plate, rotary fingers, segment guides forming the curved gutter, guards, vibrating stop and gate, constructed as set forth. I likewise claim operating the stop and gate alternately, by the combination of the radial pins projecting from the feed plate and curved arms, attached to the vibrating shaft of the stop and gate, and springs bearing against the arms, substantially as set forth."

SPECIFICATIONS OF ENGLISH PATENTS.

Specification of a Patent granted to Richard Clarke Burleigh, *of the City of Bath, in the County of Somerset, for Certain Improvements in Artificial Light.*—[Sealed, August 28, 1846.]

In order that the nature of the improvements forming the subject of the present invention may be rendered evident and intelligible, a few preliminary remarks on the nature and properties of solar and artificial light are necessary.

In solar light three colors or rays are so combined as to yield, in transmission through the azure-colored medium of the atmosphere, a perfect or colorless light: that is to say, those luminous rays which emanate by radiation from the sun and reach the earth, consist of three primitive colors, red, yellow, and blue, combined in proportions that form a compound ray, having no predominating tint; in other words, perfectly colorless. Solar light, therefore, or the luminous rays emanating from the sun, being by composition the purest and most perfect of any with which we are acquainted, I adopt such light as the standard of comparison to which every other kind of light is to be referred in judging of its quality and effects.

Now, the difference between the illuminative effects and qualities of solar or natural light, and of that produced by artificial means, will be found to consist principally in this; viz., that in the artificial spectrum, the red and yellow portions of the rays greatly predominate over the blue:

that is to say, the former are present, or emanate from the source of artificial light, in quantities over and above such as are required for a just and harmonious combination with the blue rays, to produce a perfectly colorless light similar to solar light.

This excess of red and yellow rays may not only be proved by the prism, but, as they appear to emanate (*quoad* their excess) in a free or uncombined state, they can be recognised as a positive tint or color, overlaying or painting, as it were, all objects on which they fall; hence arises the difficulty or inability of ascertaining with precision delicate shades of color by artificial light; and the excess of these red and yellow rays also causes pain and fatigue to the eye, when long exposed to its influence.

This vitiating and injurious excess of color existing in the artificial spectrum, can be corrected in any desired degree, in a perfectly simple and infallible manner. The correction is effected by transmitting the rays of artificial light through glass so prepared as to present, when formed in a proper manner, a medium analogous to that presented by the azure tint of the atmosphere to solar or natural light. It cannot be doubted, that to the purifying medium of the azure atmosphere, solar light owes in a great measure its extreme whiteness and delicacy; and by the use of such prepared glass, to which I have (looking to its effects in use) given the name of achromatic glass, the following important improvements are gained:—

The quality of artificial light becomes greatly improved as to purity; being more or less deprived, at pleasure, of its excess of color, and, consequently, of its offensive and painful glare. Its powers of diffusion, and the ability to ascertain by it delicate shades of color correctly, are greatly increased; the shadows thrown by the objects exposed to its rays are transparent, grey, and cool: thus altogether different from the hot and brown opacities forming the shadows of incorrected light; and lastly, the points most highly illuminated by the corrected light are brilliant, pure, and of true tone, in place of being loaded with a glaring and unnatural ruddiness.

On the Quality and Source of the Achromatic Power.

It is a law of light, that when luminous rays are transmitted through a colored medium, a certain proportion of the rays, complementary to the color of the medium presented, shall be neutralized or so disposed of as not to be in active and visible agency as portions of the light transmitted.

Thus, if light be made to pass through ruby-tinted glass, it will appear ruddy, because the ruby tint neutralizing the colors complementary to its own hue, namely, the yellow and the blue, allows the red to predominate in radiation. Yellow-tinted glass will also neutralize the blue and the red ray, and blue-tinted glass the yellow and the red.

From this it will be evident, that inasmuch as the excess of color to be corrected in artificial light exists in the red and yellow portions of the artificial spectrum, the base of the material or compound possessing such power of correction, must always be such as shall impart to glass a blue tint or tinge of color; and such tint or color will, within certain limits, always be a warranty and assurance that the glass so tinted possesses achromatic or purifying properties with regard to artificial light.

The material now in general use for the purpose of imparting a blue color to all vitrifiable substances, namely, cobalt, in those states of prepa-

ration known as "smalt," or "azure blue," and "zaffre," imparts to glass the power of achromatizing artificial light with certainty.

The lightest appreciable tint that can be given to glass by these preparations of cobalt: that is to say, a tint or tinge but just or barely visible to the eye when the glass is in the form adapted to use, renders such glass achromatic, or a purifier of artificial light, by imparting to it the power of correcting some certain portions of the degree of color existing in its spectrum; and from this the lightest appreciable tint or tinge of color, (which I call the lowest achromatic power,) a succession of powers may be obtained, by a gradual increase in the proportion of the achromatizing material added, and, consequently, in the depth of tint, until that point or power be reached which forms the natural boundary of their range: that is to say, a point or power where or by which all excess of red or yellow color in the emanating rays is neutralized.

It is manifest that the range between the lowest and the highest achromatic powers is capable of numerous divisions into progressive degrees or intensities, each of which will be found to possess some peculiar quality or property in use that renders it most desirable, in accordance with the required effects of illumination; such effects commencing at the lowest, and ending at the highest attainable point or degree of improvement.

Thus the exact tint or power sought in any particular instance will depend on the judgment of the manufacturer, guided by the considerations of the nature of the medium required as to form and thickness, and the character and quality of the light previous to correction, while the exact quantity of achromatizing material, added to obtain the required result, will depend on its purity and strength as a coloring agent, and also upon the peculiar character of artificial light to be corrected or achromatized.

I adopt the following tests to determine the point of highest achromatic power:—

Let a direct ray of the corrected artificial light to be tested (the light being enclosed in a fitting box or lantern) fall on a white substance, as paper side, with a direct ray of a warm sunlight as of a summer noon, in a room to which no other ray of light has access.

So long as the ray of corrected artificial light is of a warmer or ruddier quality than the ray of solar light, the achromatic power is short of its highest intensity, and therefore within the range of true achromatic powers, or further and more perfect correction. If the artificial light appear colder or bluer, the medium is too deeply tinged, and is not an achromatic but a colored medium, applicable in no way to the true improvement of artificial light by the correction of the excess of colored rays emanating therefrom. If the qualities of the respective rays be the same, then it will be evident that the highest point has been reached, and the medium is at its highest available power or state. I sometimes adopt other tests to ascertain whether the corrected artificial ray has been properly achromatized. I do not, however, think it necessary to give a detailed explanation of all the different means that may be employed, as the above has been found both simple and effective.

It may here be observed, that the highest possible attainable correction of the artificial spectrum fails to produce a light in all respects identical with sunlight. A point may indeed be reached beyond which the cor-

rected light ceases to improve in purity, as compared with a ray of sunlight, but the essential difference in the two sources of light as to intensity of combustion, powers of radiation and penetration, of refrangibility, distance of source, and nature of the respective media interposed, must prevent the attainment in corrected artificial light of many qualities, which exist in the luminous rays emanating from the sun; but that there is a visible and positive improvement in the quality of the artificial spectrum, by transmitting the artificial rays through the achromatic or purifying medium presented under the form of achromatic argand chimney or glass is evident, and that such improvement is caused by means analogous to those which render solar light so perfect can be demonstrated by practical experiment. The achromatizing material, though necessarily producing a bluish tinge in the glass containing it as evidence of its presence, cannot be considered a coloring agent merely, but is an essential constituent of achromatic glass; a constituent on the presence of which, in proper proportions, absolutely and entirely depends the existence of those qualities which render the glass achromatic, and permit its successful application to artificial light. With the exception of the achromatizing material, the ingredients of achromatic glass in no respect differ from those of glass employed in the manufacture of articles such as chimneys, globes, bulbs, shades, or other shapes which are usually employed to protect artificial light from the influence of currents or draughts of air, or other disturbing causes, or to produce the proper currents of air that may be necessary to maintain perfect combustion.

My invention does not, therefore, relate to improvements in the process of manufacturing glass, nor to the ingredients employed in such manufacture; and I do not intend to confine myself to the employment of any particular substance or substances, such as cobalt, azure, blue, or zaffre, by mixing which with the other ingredients of glass during the manufacture, a blue tint of any required depth of color may be imparted to the glass by employing suitable proportions or quantities; nor do I intend to confine myself to any particular proportions or quantities in which the achromatizing ingredient or ingredients is or are to be mixed with the other ingredients, as such proportions must depend upon the quality of the artificial light to be corrected, and the nature of the materials of which the glass is to be composed, and can only be arrived at by actual experiment to suit the several cases. The degree of intensity of color which will be required to correct the colored rays of artificial light having been ascertained in the manner herein described, the manufacturer will be at no loss to impart the proper tint to the glass by the admixture of a suitable quantity of the achromatizing ingredient. The molten metal having been properly prepared, glasses of various shapes and forms may be made by the workman to suit different kinds of burners, such as plain, straight, or other shaped chimneys, bulbs, globes, shades, or glasses of various kinds, as circumstances or cases may render desirable or necessary, or taste may direct.

Having now described the nature and object of my invention, and the manner of carrying the same into effect, I wish it to be understood that I am aware that glasses have been heretofore stained of various colors, and have been employed for the purpose of ornament, or for imparting various hues or colors to objects which have been illuminated by light passing through them. I do not, therefore, wish to claim the broad principle of

employing variously colored glasses, but that which I consider to be new, and therefore wish to secure to myself, under the hereinbefore in part recited letters patent, is the improvement of artificial light by the application of achromatic glass, (made as above described,) as a medium for transmitting artificial light, such glass being of any form or shape that may be employed for shading or protecting artificial light from currents or draughts of air, or for producing and guiding such artificial currents of air to the flames as may be found necessary to produce a perfect combustion of the matter yielding such light.—[*Inrolled May* 26, 1848.],

Rep. Pat. Inv., Oct. 1848.

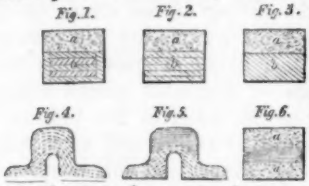
Specification of a Patent granted to George Benjamin Thorneycroft, *of Wolverhampton, for Improvements in the manufacture of Rails, for Railroads.*—[Sealed, May 27, 1847.]

The patentee commences his specification by stating that railway-bars, or rails, manufactured in the ordinary manner from piled or fagotted iron, are liable to split in the pile or laminate, which causes them to wear away very fast, to prevent this is the object of the present invention, which consists in forming the wearing part of the rail of a piece of iron of one homogeneous substance, without piling or fagotting in any way.

The patentee takes pig or refined metal of the best quality, and after puddling it in the most perfect manner, he makes one ball of sufficient weight to form the slab or bloom required for the wearing part of the rail; or, if more convenient, he combines two or more puddled balls together, (by means of a hammer, squeezer, compresser, or other suitable machine,) while the iron is in a molten state; and before any part of it has been operated upon, to make it solid or nearly solid, so that a perfect union may take place. The proper weight of iron having been thus obtained in one perfect mass, it is not to be subjected to the process of working down, and piling, and working down again in rolls or by hammers, as hitherto practised, to render the iron sufficiently ductile to be rolled into a rail without cracking; but the requisite degree of ductility is obtained by compressing the iron sufficiently to make the specific gravity about the same as when piled and re-rolled into No 2 or No. 3, bar-iron, which is what is generally used on the outer surface of the pile or fagot for making rails. Various modes of compressing the iron in one body, to obtain the required ductility, may be adopted; but the patentee does not confine himself to any particular mode of accomplishing it, so that the unpiled iron is obtained sufficiently ductile to bear being rolled or drawn into perfect rails.

The patentee, after describing the above method of making what he calls his antilaminating rails from puddled iron, describes the following mode of accomplishing the same object with charcoal iron:—He takes pig or refined iron, and makes it malleable in the charcoal refinery, bringing it out in one lump of sufficient weight to make the slab or bloom which is to form the wearing part of the rail. If it be desired to use scrap or other malleable iron for this purpose, it is to be melted down into one mass in the charcoal refinery, and compressed by hammering or otherwise, until it is sufficiently ductile to bear rolling or drawing into the rail.

The patentee states that he uses No. 1, or No. 2, iron for the back or under part of the rails; and he describes the following as the most simple means of making rails according to his invention; but he does not confine himself to any particular mode, so long as the anti-laminating iron is placed on the wearing part of the rails:—In figs. 1, 2, and 3, *a*, indicates the slab of antilaminating iron, which must always be so rolled, in making the rail, as to be upon the wearing part thereof; the back or under part, *b*, may be made of bars of No. 1, 2, or 3, iron, box-piled, (as at fig. 1,) or rolled in the usual way, (as at fig. 2,) or it may consist of a slab of iron, made from scrap, as at fig. 3. Fig. 4, is a transverse section of a bridge-rail, made in the ordinary manner; and fig. 5, is a section of a bridge-rail, made according to this invention. If rails of other sections are required to be double-headed, so as to admit of being turned, in order that both sides or edges may be subjected to wear, then an antilaminating slab must be used on both sides, as shown at fig. 6, or the rail must be formed of two slabs of antilaminating iron only.



The patentee states that his object is to keep the wearing part of the rail of crystalized and not of fibrous iron, as the latter wears much softer than the former; and for this reason he wishes to get that part of the rail which will not be acted upon by the wheels, of fibrous iron, which is not so liable to break as the crystalized iron; therefore, when the two kinds are combined, the one will assist the other. In preparing the puddled iron, small scraps may be mixed with the new iron in the puddling process, which will render the iron more ductile; but when the quality of the iron is sufficiently good, the scraps may be dispensed with, and the iron will be better without them, because the scraps, being fibrous, are much softer than the new crystallized iron, and may cause the surface of the rail to wear unevenly.

The patentee claims as his invention, the making of railway-bars of homogeneous iron in the wearing parts of the rail, or altogether, or in such proportions as may be desirable for the greater durability of the rail. —[*Inrolled, November*, 1847.] Lond. Journ. Arts & Sci., Oct. 1848.

Specification of a Patent granted to Thomas, Earl of Dondonald, Vice-Admiral in Her Majesty's Navy, *for Improvements in Marine Steam Boilers, and Apparatus connected therewith.*—[Granted, February 11, 1848.]

The principal features of this invention are the application to marine-boilers of the principle adopted for consuming the smoke in other boiler-furnaces, by admitting a stream of hot air behind the bridge, to burn the gaseous products, and the removal of the steam-chest from the top of the boiler to the end of it, thereby lessening the height. His lordship claims seven separate parts, which may be thus briefly noticed:—Firstly, the more perfect combustion of the gaseous products at their entrance into a tube-chamber, constructed according to a former patent granted to him, by combining a stream of undecomposed hot air with such products.—

Secondly, the constructing boilers with the steam-reservoir placed below the level of the water in the boiler in lieu of the steam-chest as usually constructed above the boiler. Thirdly, the drying of the steam by its being exposed to a portion of the fire-place, or by passing the flue or chimney through it. He claims, Fourthly, a mode of preventing the priming of steam-boilers by means of a plate or separator placed within the boiler, the end being below the surface of the water in the boiler.—Fifthly, the right of making and using a spiral or centrifugal separator; which, however, may be made square or other shape, and still retain the principle of the invention—namely, the separation of the water from the steam, and the mode of carrying off such separated water back to the boiler, without being obstructed by a contrary current of steam, by means of a pipe or channel from such spiral separator to the boiler. Sixthly, he claims a mode of working the propellers of steam-vessels by means of short propeller-shafts. And, lastly, a mode of constructing boat boilers and apparatus.—[*Inrolled, August* 11, 1848.]

Civ. Eng. & Arch. Jour., Sept. 1848.

Specification of a Patent granted to JOHN FREDERICK BATEMAN, of Manchester, *for Improvements in Valves or Plugs for the Passage of Water or other fluids.*—[Granted January 18, 1848.]

The chief object of this invention is to make a valve suitable for the water-pipes, the valve being made of smaller specific gravity than water, and being opened by being forced down by a plug. The claims of the patentee will sufficiently explain the structure of the valve. He claims, first, the application for the passage of water and other liquids, of a globular valve, of a lighter specific gravity than water, constructed of a coating of vulcanised india-rubber, gutta-percha, or other suitable elastic substance, so that the valve shall be closed by the pressure of the liquid.—Secondly, the use and application of a globular valve of the same or a greater specific gravity than the fluid, constructed with a coating of vulcanised india-rubber, or other elastic substance, so that the valve shall be closed without the aid of machinery, by the pressure of the liquid.—Thirdly, the opening of the valve against the pressure of the liquid, by means of a plug or key, through which the liquid will flow from the valve, the plug or key being attached to the fixed part, without the aid of any screw or thread.—[*Inrolled, July* 18, 1848.]

Ibid.

Specification of a Patent granted to WILLIAM RUSSELL, of Lydbrook, Gloucestershire, *for an Improvement in the Preparation of such Bar-iron as is used in the manufacture of certain kinds of Rod-iron.*—[Granted, January 29, 1848.]

This invention may be very briefly described. The object is to remove from the surface of ordinary bar-iron the spill or scale, which is found to be very injurious in making the billets from which wire-rod-iron and horse-shoe-nail rod-iron are manufactured. The scale is removed by passing the

bar-iron through a kind of draw-plate called a "cleanser," composed of grooves formed in the shape of the letter "V." In conducting the operation, the iron is first made into lumps of about one hundred-weight and a quarter. It is then removed to the hammer, where it is reduced by hammering to short bars of five or six inches square. It is next passed through the rolls in the usual manner, and reduced to bars of about one inch and a quarter square. In passing through the two last and finishing grooves in the rolls, opposite which the cleanser is placed, the lower half is slightly lowered in order to admit of the entrance of the bar to the rolls which draw the bar through. During this finishing operation pressure is exerted to bring up the cleanser by means of the lever and shaft, thereby scraping the iron on all its four sides, and effectually removing all the spill and scale from the surface. The bar is then passed over the upper roll, and is introduced through a smaller groove in the rolls, when the operation of scraping is repeated, as before.—[*Inrolled, July* 29, 1848.] Ibid.

Specification of a Patent granted to Richard Shaw, of West Bromwich, Stafford, *for Improvements in the manufacture of Wrought-iron Railway Bars and Railway Chairs.*—[Granted, October 21, 1847.]

The improvements described in this specification relate to the construction of railway-bars and railway chairs, as also the arrangement of the machinery for their construction; and consist, First, in the mode of forming and piling the pieces of iron to form the railway-bar, for preventing the lamination of the metal. This is effected by placing and piling the bars in the manner shown in the annexed diagram, fig. 1, the lower portion of the bar being piled in the usual manner with flat bars, and the upper portion piled with a broad bar bent into the form shown, the edges abutting upon the surface of the bars beneath, and the interior being filled and piled in the usual manner. When the railway-bar is finished, the grain of the metal is arranged in the form represented in fig. 2, and thus no laminating edges occur on the head of the working surface. The other improvements claimed by the patentee are, Secondly, the mode of manufacturing wrought-iron railway bars with protecting rails or flanches affixed thereto, in such a manner that the heads or working surface of the railway-bar stands above the support of the protecting rail or flanch. Thirdly, the mode of manufacturing railway-bars with hollow heads or working surfaces in such a manner that the cheeks of the chairs may pass into the hollow of the head or working surfaces for the purposes of support. Fourthly, the mode of rolling railway-bars with rollers placed three high; as also the mode of rolling by the same means the curved bars used in placing and piling for making his improved railway-bars. Fifthly, the construction of chairs for supporting his improved form of railway-bar. —[*Inrolled, April* 21, 1848.] Ibid, June.

Fig. 1.

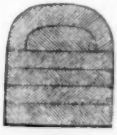
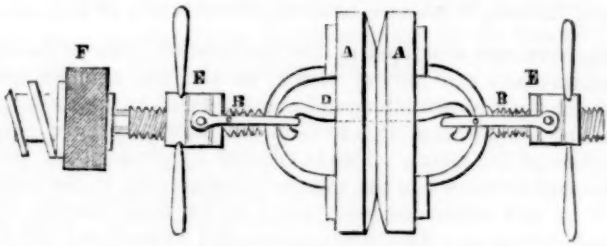


Fig 2.

Specification of a Patent granted to Richard Wrighton, of Grosvenor Square, *for Improvements in Apparatus to be applied to Railway Carriages and Engines.*—[Granted, December 22, 1837.]

The apparatus consists of five distinct applications to railway carriages and engines for different purposes. The first part consists in the construction of apparatus attached to the brakes of railway carriages, the actuating force uopn the brakes being that of steam. The patentee claims under this head of his specification, the combination and arrangement of apparatus, whereby the piston of a steam-cylinder may be made to act upon central traction-rods or shafts, for the purpose of working the brakes of carriages and causing them to act simultaneously upon the wheels throughout the whole train; also the construction of box-coupling for connecting the shafts and the power to the brakes.—The second improvement consists in the employment, in railway carriages, of one central buffer in lieu of the two side ones, as hitherto used; this the patentee constructs in combination with the draw-link. The annexed diagram represents this arrangement. A A, are the buffer-plates of adjoining carriages: they are



attached to the buffer-rods B B, the ends of which are made of the looped-form shown, for the purpose of admitting the loop of the connecting-links C C. The buffer-plates A A, are made with holes through their centres, through which are passed the double-ended hooks D, when the carriages are required to be connected, which are hooked to the links C C, upon the buffer-rods B B. Immediately behind the loop are cut threads, upon which work the nuts E E, upon which are loose collars, that do not revolve with the nuts. To the loose collars are attached by studs the links C C; when it is required to connect two carriages, the buffer-plates are brought together, the two nuts are turned up to the looped ends of the buffer-rods, and the double hook inserted and hooked on to the links; the nuts are then to be turned back until the links and the hooks become tight. Instead of passing the traction-rods entirely through the carriage as hitherto, the patentee passes the rod B, only through the end-frames F F, of the carriage, where the helical spring G, is placed upon the rods, and acts as the buffing-spring. The patentee claims as his third improvement, the employment of helical springs or other elastic substance, in combination with adjusting-screws, for making the couplings of railway carriages; also the combination of a double-joint with the adjusting-screws.

The patentee's fourth improvement consists in constructing the axle-box and the axle in such manner that the lubricating material employed shall be retained in contact with the journal and the bearing, and thereby prevent a considerable portion of the waste which has hitherto taken place with axle-boxes as usually constructed. He constructs the axle of one piece or of two pieces, as in the usual way; the brass forming the bearing is properly fitted in, and the end of the axle is inserted into the axle-box from the back; the axle inside against the journal is turned with a flat or taper shoulder, against which is fitted and placed a metal ring; between the ring and the back of the axle-box is inserted a ring of vulcanized india-rubber, or other similar substance, thereby preventing the escape from the axle-box of any considerable portion of the lubricating material employed. The fifth improvement consists of a means of enabling any of the passengers in railway carriages of a train to signal and communicate with the engine-driver or guard, by the aid of electricity. To the middle partition of each railway carriage, near the roof, is fixed a small voltaic battery, by means of which the passengers are enabled to bring into action an electro-magnet, that explodes a percussion cap or rings a bell. —[*Inrolled, June* 22, 1848.] Ibid, Aug., 1848.

MECHANICS, PHYSICS, AND CHEMISTRY.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Paddles of Steamers—their Figure, Dip, Thickness, Material, Number, &c. *By* THOMAS EWBANK, ESQ., *City of New York.*

(Continued from page 60.)

The foregoing experiments and remarks relate chiefly to the *figure* and *dip* of paddles. Other traits next solicited investigation; and, though neither prominent, nor promising any adequate reward for the requisite labor, they were thought worth attending to, since engineers will certainly be urged shortly to cast about for every means of adding, though ever so little, to the speed of steamers.

Buoyant or Displacing Paddles.

It had been imagined, that the resistance which fluids oppose to the sinking of bulky bodies in them, might be employed as an element of propulsion—that if close barrels, for example, were fastened to the arms of a wheel, their ends would act as paddles, and the force required to plunge them, (equal to 62 lbs. for each cubic foot of water displaced,) also react favorably on the boat. To test this idea, eight square and tight boxes, 7 inches by 7, and 6 inches deep, were secured to the arms of one wheel, and set to work against the eight blades, No. 1, (fig. 3,) on the other. The boxes required, very sensibly, more power to carry them round than any other tried, and were miserably deficient in pushing the vessel forward with it —certainly not equalling four of the competing blades. They produced quite a commotion in the water, carried large quantities over with them, and,

could we have communicated sufficient velocity, would probably have formed a vertical ring of it. These boxes were, and should be, considered simply as unusually *thick* blades. All paddles are buoyant in proportion to their thickness.

Thickness of Paddles.

But though worthless in one respect, they were valuable in another, for they led us to the fact, or the law, that the propelling virtue of blades expands and contracts with their thickness. Thicken them till they touch each other, and they form a perfect drum, which could exert no more propelling power than a revolving grindstone;—reduce them to the thinnest plates, consistent with the strains they have to oppose, and in the same ratio that property is augmented in them.

The boxes were removed, and boards, $\frac{7}{8}$ths of an inch thick, and 7 inches square, put in their places. These represented common plank paddles, and were found sensibly inferior to their metalline competitors, whose thickness was slightly less than $\frac{1}{16}$ inch. We next took away two of the latter, when no very obvious change in the boat's direction occurred. When two more were taken off, the remaining four were unable to contend with the wooden ones. These, it will be remembered, were $\frac{1}{7}$th the thickness of the boxes, and consequently inherited that proportion of their defects.

It was also very observable how much more water was raised by the boards than by the plates. It could not easily be cast off their blunt boundaries, but kept running over them, from one side to another—a fact rendered more distinct in the boxes. Nothing could declare plainer, that the sharper the dipping edges of paddles are made, the more back water they throw off at the point where its departure is most beneficial: that is, when the re-action favors the vessel's progress—and, consequently, less is carried higher than the axis. A very little labor would impart this feature—in other words, would make their section a wedge. The resulting benefit would repay the expenditure a hundred fold.

Compared to metal, wood approaches in its nature to sponge; water clings to it; its pores are absorbing vessels, that suck it in, and assist to retain it on the surface.

Here nature also confirms the positions arrived at. Extreme tenuity of blade is stamped with perfection by her. Hence we see it strengthened by reticulated bars in the wings of insects—by radial, angular, and tapering, ribs in the fins and tails of fishes. An uniformly thick, and unsupported slab, like our paddles, is nowhere met with. We cannot imagine natatory or soaring organs, formed after such a pattern, without feeling the absurdity.

The caudal propellers of fishes are necessarily thick where they join the bodies, but how rapidly is the substance diminished, and to a mere film, at their extremities, so much so, that they are often there torn and jagged, by accident or wear, as fishermen well know. There must, therefore, be some powerful reason for withholding the material—one that overbalances all inconveniences resulting from its absence; and what can it be but the thinner the blade, the more efficient as a propeller it is—the longer is its stroke, and the more effectual is the power that wields it. The same law

prevails in the wings of birds; their outward boundaries are feathered off to almost nothing.

The reflection is irresistible. With what nicety and care Nature perfects her propellers, and how clumsy and unfinished are ours; as if, forsooth, a vessel's progress did not depend upon them!

The last two experiments demonstrate, that the less water a paddle *displaces* by its volume, the more efficient it is; that all accumulation of material behind its acting face, beyond what is absolutely necessary to strengthen it, is injurious, and ought to be avoided. But how does this accord with the current practice? Oaken planks are universally employed, and I have heard more than one engineer assert, that the thicker they are the better! Because, said they, if their propelling property be not enhanced, it is not diminished, and their additional weight is a positive advantage, since the heavier the wheels are, the easier they work—the more uniform are their movements.*

The "Gorgon," an English steamer, had "large wheels and little power," so she used oak or pine scantlings, 5 inches by 6, or 6 by 8, for paddles. Had her managers been aware of the true effect of thick blades, they never would have adopted them with the view of economizing power.

Paddle planks vary in thickness from $1\frac{1}{2}$ to 3 inches. No sea steamers have them less than 2 inches. In the English vessels they are $2\frac{1}{4}$; in others, as the *Franklin*, they are $2\frac{1}{2}$; in some of the largest class they are 3. The *Atlantic* and the *Pacific*, each of 3000 tons, now building for the Collins' Line, are to have them 3 inches. The former is to have 28 blades; hence, united, they will form a solid mass, *seven feet* thick, in each wheel—just one-fifth of its diameter! They are to be $12\frac{1}{2}$ feet long, by 34 inches; those of both wheels will, therefore, contain nearly 500 cubic feet of timber, and must displace that enormous volume of water at every revolution, by their submersion alone!—and, as we have seen, not only uselessly, but with a serious retardation of the vessel's headway, and waste of her motive power.

The wheels of the *Pacific* are to be 36 feet in diameter; each will have 30 blades, $11\frac{1}{2}$ feet, by 3 feet; the solid contents of her paddles will, therefore, equal 517 cubic feet. Her loss from the same source will, therefore, be greater. In *every* revolution of *each wheel*, her paddles will lose $7\frac{1}{2}$ feet of effective stroke, and those of the *Atlantic* 7 feet! Those of the ocean steamer *United States* are $2\frac{1}{4}$ or $2\frac{1}{2}$ inches thick; they are 36 in number, but as they are "split," and attached on both sides of the arms, there are really 72. They certainly diminish the effective strokes of her blades, from 10 to 15 feet, in every turn of her wheels, startling as the assertion is.

Has the attention of engineers ever been turned this way? Or have they forgotten, that a volume of water equal to that of a boat's paddles, and every inch of material submerged with them, is neutralized as a resisting

*As a further indication that the value of thinness in blades, and of their disincumbrance from every pound of material extraneous to their functions as propellers, has not hitherto been appreciated, it may be remarked, that the same language was repeated in my hearing thus:—"A few tons of wood in the buckets do no harm, if they do no good; they add weight to the wheel, which is desirable, and their only disadvantage is, the additional load on the boat." I believe this is the general, if not the universal, opinion of engineers. But the experiments just referred to, teach us that, if a wheel require loading, the load should be attached to those parts of the arms that revolve above the surface. They cannot enter the water without becoming drags on the blades.

medium, as often as it is displaced by their immersion;—that water is to them what steam is to pistons—the more space the latter occupy in cylinders, the shorter becomes their stroke, because metal then takes the place of steam; the object to be moved crowds out the mover. Thicken a piston till it fills its cylinder, and the motive agent being wholly kept out, all motion ceases.

It is much the same with the paddles of a wheel. Let them fill up $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{3}$, or $\frac{1}{2}$, of the circles they describe, and in those proportions they lose their virtue, because in the same proportion they displace, or push aside, the fluid agent on which their worth depends.

The *Atlantic* will lose *seven feet* stroke in every turn of her wheels. I leave to mathematicians to determine, how many more miles an hour she would make, if the loss were reduced to *seven inches*, by using $\frac{1}{4}$-inch iron, in place of 3-inch plank.

There are several interesting questions about paddles that yet require solutions, but as respects their thickness, there is no *mean* to seek; the thinnest is the best under all circumstances—thin, were it possible, as a lamina of mica. The only question is, What material will supply the thinnest sheets to resist the pressure they are to oppose? Plates of steel, I opine, will yet be adopted.

To one remark, an examination of some steamers' wheels adds force.—The accumulation of bolts, nuts, clamps, straps, stays, and other things, on and about the backs and faces of paddles—sometimes even to bolting a new plank, or part of one, over an old one—show that those who heap on matters of the kind, are not aware now much the efficacy of blades are thereby diminished. They forget that they should be thin and smooth as plates of glass, and that every inch of matter introduced between them, is an evil. It is impossible to view the disjointed, broken, patched up slabs of some vessels, without exclaiming, "What a saving of power, and increase of useful effect, would not the substitution of a suitable sheet of metal for each accomplish!"

A new division of engineering, I sometimes think, might judiciously be made, and paddle-making be recognized as a distinct department. These instruments have certainly never received the attention which they merit. Speed is the great desideratum, and it depends on them. Engines, and all the mechanism of a steamer, are subservient to them, and yet, while everything else has been elaborated to the utmost, they have been all but overlooked.

In some vessels—the United States mail steamer *Galveston* is one—strips of plank are bolted over the ends of the paddles to prevent their splitting, or warping. As they do not diminish the faces, but merely form elevations upon them, they are doubtless considered as in no degree interfering with the propelling function. We now perceive that, when such things are necessary, they should be of iron, and let into the blades, so as to be flush with their surfaces.

Number of Paddles.

The experiments of each day convinced us that, so far as propulsion is concerned, the fewer the paddles, the faster went the boat, so long as *one* at each wheel, or an area equal to the face of one, was kept in full play.

A greater number in the water merely cuts it into slices, throws them into commotion and diminishes the resistance they should oppose to the blades. As a further elucidation of this fact, we tried, at the suggestion of Mr. B., four blades, 7×14, against the eight test ones, 7×7. The smaller number had a decided advantage over the greater, and the cause was visible: they had a full sweep, through an unbroken, undisturbed, mass of fluid, and consequently produced, unabridged, their legitimate effects; while those on the other wheel—unusually small ($\frac{1}{3}$ or $\frac{1}{4}$) as their number was, compared to those on the wheels of steamers—following so quickly in the wake of one another, threw it into an uproar, causing eddies, whirlpools, and counter currents, and thus interfering with each other, necessarily produced inferior results.

We thought 8 of fig. 4 would be equally valuable as 24 of fig. 3, but the construction of our wheels prevented us from instituting a series of similar comparisons.

The number of paddles now employed is, generally, greater than formerly. For large vessels, 28 are usual; some have 24, and others 32. The English rule, said to be a good one, is adhered to by many American engineers, except when circumstances require a deviation. By it, there is a paddle for every foot of a wheel's diameter, which makes them stand three feet apart; there are boats in which they occur every two feet.

One object of their multiplication, is to equalize the jar of their striking the water, by increasing the number of the blows. With the same view, they are often split through the middle, lengthwise, and the inner half—that next the shaft—removed to the opposite side of the arm, as in the end view, fig. 26, thus *doubling*, in a manner, their number. All the British steamers have their blades thus arranged. The *Hermann's* 28 were thus made into 56; their efficacy was found to be reduced about 9 per cent. The value of the upper or inner halves has been ascertained to be about the same, for, when wholly removed, the lower portions have proved within 10 per cent. as effective as before. The blades of the *United States* are split, and disposed as in the figure. The true principle of breaking the jar of paddles striking the water, seems to me to be indicated in the blades 4, 5, 8, 9, 10, 14, 15, 21, 22, 23, 24, 25. Had the attention of engineers been led to it in the early days of steaming, the popular plan of avoiding the evil at the expense of a greater, would not have been sanctioned so long.

I observed the blades of the last named steamer, a week after her recent return from Europe. *Seven* were submerged, or *fourteen*, if those on both sides of the arms be counted. She sailed on the 4th inst., for New Orleans, with eight (or sixteen) under water. The *Cherokee* left on the 1st inst., for Savannah, with *six* of her undivided blades below the surface. The *Washington* came in on the 6th inst., from Bremen, with *five* similar ones fully immersed on each side—four full ones, and the halves of two others. The largest of our Sound and River boats have equal, if not greater numbers under. The *Vanderbilt*, 1200 tons, has *five*, or *ten* halves, immersed in each wheel, when lying at her dock, and without passengers on board. The *Isaac Newton*, 1200 tons, has similar wheels, and the same number of blades under water at once.

It is clearly as impossible for a paddle to do its duty, when thus embarrassed among its fellows, as for a traveler to make the same progress through a crowd, as on an open plain.

27

As sea steamers have little occasion to go stern-forwards, the backs of the acting faces are occasionally dressed off, as shown by the outline of fig. 27. As far as the lower, or dipping, parts are concerned, this is an advantage; but, from the preceding experiments, it is seen how much more beneficially such blades would act, were those parts brought to a knife-edge, and their sections bounded by the dark part of the cut.

Arms of Wheels.

The practice of making the arms of paddle wheels of uniform, or nearly uniform, dimensions throughout, is also wrong. They may, without diminution of strength, be reduced towards their extremities, and ought to be, since every inch of surplus material submerged in them, detracts from the work done by the blades. They should taper outwards, as Nature tapers the radial ribs in her propellers.

Coating Paddles with Materials that Repel Water.

If any substance can be found, durably to prevent paddles from being *wetted*, they would then carry over less water with them. We coated one set with grease, (suet,) and, while the water streamed uniformly over the faces of others, it adhered only in narrow streaks to these.

Besides the paddles described, some others were tried, but, as they involved different principles, and were not of very practical application, their introduction here is not necessary.

These results sustain but partially, the views expressed in the article inserted in a former number of the Journal.* The form of blade there proposed removes but one evil. The value of those figured on page 267, Vol. XVI., can, from data here given, be readily ascertained.

The lessons which the foregoing experiments teach us are:—

That, to render paddles of steamers more effectual, they ought to be fashioned, as far as circumstances sanction, after models furnished by Nature, so as to conform to her general practice of contracting surface when resistance is of little avail, and extending it when the latter is greatest—to give the largest portions of blades the longest strokes.

That the fewer the paddles on a wheel the better, provided *one* be always kept in full play;—and hence, that it would be more advantageous to point, or fork them, as proposed, to evade the jar of their striking on the surface, than so perniciously to split and multiply them, as the popular practice is.

That smooth and thin metallic plates should be substituted for the usual massive, water-soaked planks. (At present, perhaps, nothing better than boiler-plates, galvanized, could be adopted.) That bolt-heads, nuts, cleats, straps, and every other projection, upon, or about, them, should be provided against. That the arms of wheels ought to be reduced at their outer extremities, and the immersion of all superfluous material carefully avoided. That, when wheels require balancing, or their momentum to be increased, the weights should be attached to the arms above the surface of the water.

* Journ. Frank. Insti., Vol. XVI, p, 264.

To coat paddles, and parts that plunge with them, with varnish, or other substance that repels water, that the fluid, instead of being dragged up in volumes by them, may roll from them, as from the backs of diving birds.

Some persons smile at the idea of machinists studying nature; and such, on perusing the preceding suggestions, will deem it a sufficient reply, to remind the proposer, that steamers are not blackfish, nor paddles salmons' tails, nor petrels' feet.

But minds differently organized, think a glance into her workshops is never amiss, and that the longer the visit, the better for the visitor, since there is no art or contrivance, (and it is certain that, through eternity, there never can be one,) which has not its prototype in her collections. If we find them not, it is because of inattention, or of an imperfect acquaintance with her stores. Perhaps we know not at which of her ateliers to inquire, or are not prepared to appreciate specimens laid before us when we enter.

No person, of course, expects to find in living mechanisms, exact copies for artificial articulations; but when a mechanical principle, and the instruments through which that principle is manifested, are before us—when we see motion communicated to a class of organs, comprehend their construction, effect of their forms, modes of their action, and dynamic results—there is no difficulty in making such deviations, as difference in materials, powers to be employed, and conditions under which the artificial machine is required to act, may require. It is the perfection of invention thus to *imitate* Nature—the maturity of science and art to tread in her steps.

It would be wrong to close this paper, without acknowledging many obligations to Mr. John Bell, of Harlem, by whose assistance the experiments were conducted; a gentleman whose judgment on general mechanics is not surpassed; and to Mr. Mott, for the use of a boat, and facilities for making the various paddles tested; to Messrs. Morris & Cummings also.

Mr. Bell has matured a substitute, which he proposes for paddle wheels, consisting of two reciprocating arms on each side of a vessel. At their extremities are folding blades, or vanes, which open when sweeping in one direction, and close in the other. He dispenses with the cumbrous paddle boxes, and leaves the deck nearly clear;—at the same time increases the sweep of the blades beyond what is practicable with wheels, by simply elevating (on framework resembling that of beam engines) the points of their suspension.

From Mr. Allaire, and from Mr. Stillman, the well-known principal of the "Novelty Works," were derived many valuable facts.

New York, November, 1848.

Note.—Since the above paper was written, I have seen in the Journal of the Franklin Institute, for February, 1842, (3d series, vol. 3, p. 102,) an extract from the Civil Engineers' and Architects' Journal, for October, 1841, by which it appears that Mr. Rennie was led, by his experiments, to substitute the diamond-shaped paddle (fig. 8) for that of the ordinary form. It is there stated, that, "after a great variety of experiments, he found that a paddle wheel of one-half the width and weight, and with trapezium floats, was as effective in propelling a vessel, as a wheel of double the width and weight, with the ordinary rectangular floats." This agrees very well with my own results. (See p. 45.) Mr. Rennie states that the

Admiralty had permitted him to fit H. M. ship African with these wheels, and he had perfect confidence in the success of the experiment; but I have not been able to find any account of the results of this trial upon a large scale.

Measures have been taken to secure by patent, the improvements developed by the preceding experiments.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Account of the Experiments to determine the Principal Laws and Numerical Data, which enter into the Calculations of Steam Engines. By M. V. REGNAULT.

NINTH MEMOIR.

On the Latent Heats of Saturated Vapor of Water under Different Pressures.

(Continued from page 60.)

The object of this ninth memoir is to determine the quantity of heat which it is necessary to give to 1 kilogramme of water at 0°, to convert that water into saturated steam under different pressures. These quantities of heat are expressed by M. Regnault in terms of the number of kilogrammes of liquid water which they would heat from 0° to 1° Cent. We have kept these numbers, except in the final table. There we have added a column expressing the same results in degrees Fahrenheit.

Dr. Black was the first to observe the phenomenon of the absorption of heat during the conversion of water into steam, and he even attempted to measure it. The number he obtained was 530; a number much too small, because he did not take the necessary corrections into account. (*Lectures on the Elements of Chemistry, vol.* I.)

The celebrated Watt made experiments at several different times upon this subject. The first attempts were made in 1765, and gave him the number 766, which he himself regarded as incorrect. He resumed the subject in 1781, and performed the experiments which he describes in the article *Steam* of Robison's *Mechanical Philosophy*. The mean of 11 determinations gave him 625·2, which he regarded as too small, and adopted, as more probable, 633·3.

Rumford sought for the same element by means of his calorimeter, (*Biot, Traité de Physique, tom.* IV, *p.* 710,) and found the numbers 669, 670·8, 671·9.

Dr. Ure published in the *Philosophical Transactions for* 1818, *p.* 385, a memoir in which he proposes to determine the latent heats of vaporization of a certain number of volatile substances. The number he obtained for water boiling under atmospheric pressure was 637·5; but it must be remarked that, as M. Brix has already remarked, (*Poggendorff's Annalen, vol.* LV, *p.* 351,) his results were calculated by an incorrect formula, and when this is corrected, the number deduced from these experiments is 593·4.

In this memoir, Dr. Ure states that Lavoisier and Laplace had found

the number 655, but M. Regnault states that he has searched the memoirs of these distinguished chemists in vain for this determination.

M. Biot states, (*Traité de Physique, tom.* IV, *p.* 713,) that M. Gay Lussac and MM. Clement and Desormes had, independently of each other, got the number 650, but M. Regnault has not been able to find the details of their experiments. The most important and most recent experiments upon this subject, are those of M. Despretz, and of M. Brix.

In a first series of experiments, (*Ann. de Chimie et de Phys., tom.* XXIV, *p.* 323,) M. Despretz used an apparatus similar to that of Rumford; the number which he got was 631. In a second series, using a larger apparatus, he got the number 640.

M. Brix, in his memoir, (*Poggendorff's Annalen, vol.* LV, *p.* 341,) has gone into a lengthened discussion of the various sources of error which affect the method of mixtures, applied to the determination of the latent heat of vapors, and sought by a long series of trials to make the sum of these as small as possible. His apparatus was too small, but the number which he obtained was 640; the same obtained by M. Despretz in his second series of experiments. The number generally adopted is 650.

The investigators here cited had for their object the determination of the latent heat of water under the ordinary atmospheric pressure; the experiments for the purpose of determining this quantity under other pressures are much less numerous, and very imperfect.

Watt assumed that *the quantity of heat which must be furnished to a pound of water to convert it into vapor, under any pressure whatever, is constant;* in other words, that *the sum of the latent heat, and the temperature of saturated steam, is constant at all pressures.*

This proposition, known as the *Law of Watt*, can only be considered as a hypothesis of that celebrated man, for he did not establish it by direct experiments; he made but one experiment at a pressure less than that of the atmosphere, and that, as he himself admits, was very imperfect. (*Robison's Mechanical Philosophy, vol.* II, *p.* 8.)

Southern and Creighton made in 1803 more extensive experiments, to determine at the same time, the density of saturated steam at different pressures, and its latent heat under the same circumstances. Their observations are recorded in a letter addressed to Watt, and published in *Robison's Mechanical Philosophy, vol.* II, *p.* 160. From their experiments, they concluded that *the latent heat of vaporization, that is, the heat absorbed in passing from the liquid to the gaseous state, is constant under all pressures; and that the total heat is to be obtained by adding to the constant latent heat the temperature of the steam.*

This law is known as *Southern's law.*

In 1809 Clement and Desormes made new experiments upon this subject. They used a large boiler in which the water could be boiled under different pressures, and they condensed equal quantities in a condenser which had in it, in each experiment, the same quantity of cold water at the same temperature. They thus found that the water of their condenser had the same temperature at the end of every experiment. Their experiments thus confirmed the law of Watt. (*Thenard, Traité de Chimie, tom.* I, *p.* 78.)

M. Despretz, (*Traité de Physique, 4me edition, p.* 212,) states that he has made many experiments to determine the latent heat of steam under

great pressures, but was stopped by the difficulty of constructing apparatus which would stand the pressures; that nevertheless he thinks himself entitled to infer from his experiments, that the total heat of the vapor increases with the temperature.

M. Dulong appears to have arrived at the same conclusion. (*Lamé, Cours de Physique, tom.* I, *p.* 487, 1*ere edition.*)

Machinists have generally adopted Watt's law, which is very convenient for their calculations, and which, moreover, seems to be confirmed by the fact that it requires about the same quantity of combustible to produce a pound of steam under a high or a low pressure.

M. De Pambour, (*Traité des Locomotives, etc., 2me edition, chap.* II *and* VII,) finds a confirmation of Watt's law in the experiments which he tried upon a locomotive. This skilful investigator observed that steam forming in a boiler, under an absolute pressure varying from 2·7 to 4·4 atmospheres, and escaping into the atmosphere under an actual pressure of from 1·4 to 1·03 atmosphere, presented at its issue exactly the same temperature, as though it were saturated. This circumstance accords with the law of Watt; while, according to the law of Southern, the steam ought to issue at a higher temperature, which ought, theoretically, to be that which it had in the boiler. But in order that these conclusions of M. De Pambour may be rigorously admitted, it is necessary to suppose that the steam experiences no cooling while passing through the machine, and that it is perfectly dry when it leaves the boiler: neither of which admissions are likely to be true.

Finally, several authors have endeavored to establish, some the law of Watt, some that of Southern, by *à priori* reasoning, but it is not necessary to discuss their speculations, since evidently the facts can be decided satisfactorily only by experiment.

M. Regnault then proceeds to discuss the method of determining the latent heat of steam by the use of the calorimeter, and notes the following sources of error for which corrections must be applied:—

1st. The distillation of the liquid requires a certain time, during which the calorimeter loses a quantity of its heat by radiation, and by contact with the surrounding air; the final temperature is, therefore, lower than it would have otherwise been.

2d. The pipe which conveys the steam into the worm carries also, by conduction, a certain quantity of heat, which raises the temperature of the calorimeter.

3d. The steam which passes over into the calorimeter necessarily carries with it, in the ordinary method of proceeding, particles of water, either brought from the boiler or arising from partial condensation in the pipe.

4th. In the experiments hitherto made, to determine the latent heat of steam under pressures greater than that of the atmosphere, the steam was generated under high pressure, but immediately upon leaving the boiler it was reduced, in the tube which led it to the calorimeter, even to the pressure of the atmosphere. Now it is difficult to say what takes place during the enormous dilatation which the steam thus undergoes; a very great loss of heat may ensue, especially if the conducting pipe is very long, as is inevitably the case if the boiler of a steam engine is used for the purpose.

5th. The water which is collected in the reservoir of the worm, has not exactly the same temperature as the surrounding water of the calorimeter, at the instant when its maximum temperature is noted. When the experiments are made only under the atmospheric pressure, this difference may be estimated with sufficient accuracy by the indications of a small thermometer, whose reservoir is placed in the centre of the reservoir, but this method is no longer applicable when the vapor is condensed under heavy pressures.

M. Regnault's apparatus was as follows:

His boiler was of wrought iron, 0·5 in. thick, and capable of holding about 80 gallons of water. It was furnished with tubes for the thermometers, and was connected with the conducting tube, the mouth of which was about the centre of the steam-space of the boiler, from which point it was wound around in the inside of the boiler for a length of 13 feet, when it passed through the side, and was surrounded for its whole exterior length by another larger tube, serving as a jacket, the interval between the two being in free communication with the boiler, and therefore always supplied with steam of the same temperature and pressure as that within the pipe. This jacket was wrapped in woollen to prevent loss of heat.

The conducting tube led the steam to a peculiarly constructed stop-cock, by which it could be passed at pleasure, either immediately to the condenser, which was kept cool by a constant supply of water, or to either of two exactly similar calorimeters of thin copper, which were placed one on each side of the distributing cock, and connected with it by pipes as short as possible, and carefully wrapped. The calorimeters were furnished with equal weights of water by a gauged vessel, which is permanently fixed above them, and communicates with either of them at will.

The worm consists of two thin copper globes placed vertically above each other, and connected together by a tube from the bottom of the upper to the top of the lower. At the bottom of the lower one is a tube and stop-cock, passing without the calorimeter, by which the condensed water could be withdrawn from the worm.

From the upper part of the lower globe a helical tube rises, which makes several convolutions in the calorimeter, and then rising through the cover, is connected with a small box, which, by other tubes, is connected with each of the other pieces of the apparatus, so as to insure an equality of pressure throughout. The boiler and this pressure-regulator are connected with a large copper vessel immersed in a much larger vessel of water, and communicating on the one hand with the boiler, and with the long mercurial gauge formerly described, and on the other hand with an exhausting or condensing pump, according as the experiments are to be tried at pressures below or above that of the atmosphere.

In performing the experiments, the pressure of the air in the air vessel, and consequently in the boiler, was first adjusted, and the water made to boil freely; the steam which passed along the conducting tube was, by the regulating cock, thrown immediately into the condenser, without passing through either of the calorimeters, until the whole apparatus had got an equilibrium of temperature, and the distillation of the water was proceeding with perfect steadiness. Advantage was taken of this time, during which the calorimeters were not in use, to determine the quantity of heat con-

ducted by the tubes into the calorimeters for a given difference of temperature between the two, and when all was ready, the experiment was commenced by adjusting the regulating cock so as to throw a part of the steam into one of the calorimeters. The quantity thrown in depended upon the will of the operator, who was governed by his desire to have the experiment conducted more or less slowly. The direct discharge into the condenser was, however, never entirely stopped. When the experiment was finished, the steam was shut off from the calorimeter, the lower stop-cock of the worm opened, and the water discharged into a glass vessel, in which its temperature was noted by a thermometer. The thermometers in the water of the calorimeter, (which was kept constantly stirred by a proper apparatus,) were watched until they reached a maximum; during the time occupied with which, an assistant weighed the water condensed in the worm. The steam was then turned into the other calorimeter, and a second experiment begun; but in the mean time, the rapidity of cooling of the calorimeter not in use was tested, in order to apply the proper corrections to the one in use; and so by this alternate use, there is, as M. Regnault remarks, neither beginning nor end to the experiment, and the errors at the beginning and end are avoided.

As to the corrections, that for the loss of heat by radiation and contact of air, of the calorimeter, were carefully studied and applied from the data furnished by the observations on the twin calorimeter not in use; that for the increase of temperature by the conducting power of the tubes, is directly determined. The peculiar arrangement of the end of the connecting tube within the boiler, prevents any carrying of water from it, while the jacketing prevents the condensation of the steam; the steam is kept under the same pressure until its condensation by means of the pressure-regulator. Finally, the error arising from the condensed water not being at the temperature of the water of the calorimeter, is reduced to a minimum, and data for a sufficient correction applied.

The experiments made in this way were very numerous, and extended from a pressure of 0·643 atmosphere to 13·625.

The experiments under very light pressures having very irregular results, owing to the want of steadiness of the ebullition in the boiler, M. Regnault reversed the method of operating at low pressures, so as, in place of determining the quantity of heat which saturated vapor abandoned to cold water, to determine the quantity of heat which a known weight of water absorbed in passing into vapor. By this means he made a series of experiments, varying from a pressure of 3·9 mm., (0·154 in.,) to 13·6 mm., (0·516 in.)

The results of all these experiments shew that the total quantity of heat necessary to convert a pound of water into steam, at any given pressure, increases from 610, which is the value of the total heat of the vapor under 0·01 atmosphere, up to 666, which is its value under 13·6 atmospheres; Watt's law is, therefore, not true.

On the other hand, if the temperature of the steam be subtracted from the value of the total heat, the remainder constantly decreases as the pressure rises. But, according to Southern's law, this remainder should be a constant quantity.

The law of Southern is less in accordance with the results of the experiments than that of Watt.

M. Regnault thinks that our numerical data are not yet known with sufficient correctness, to allow us to determine the physical law which connects the total quantity of heat with the temperature at which the steam is formed. In the mean time it is evident that we can develope this value by the series of ascending powers of T, by means of a formula of this form,—

$$\lambda = A + BT + CT^2 + DT^3 + \&c.$$

And M. Regnault has found that the first two terms are sufficient to bring the calculated results within the errors of experiment. He therefore has calculated the following table from the formula

$$\lambda = A + BT,$$

in which λ = the total quantity of heat of the vapor.
T = the temperature.
A&B = constant coefficients determined by experiment.

If Watt's law were true, we should have, B=0.

$$\lambda = A.$$

The constant B there represents, as it were a peculiar specific heat of the vapor which belongs to it at all temperatures.

The formula as calculated by M. Regnault for the centigrade thermometer is

$$\lambda = 606{\cdot}5 + 0{\cdot}305\ T.$$

Temperature of the Saturated Steam.		Corresponding Elastic Forces.	Total Heat. *	
Fahrenheit.	Centigrade.	Atmospheres.	Cent.	Fahr.
32°	0°	0·006	606·5	1091·70°
50	10	0·012	609·5	1097·10
68	20	0·023	612·6	1102·68
86	30	0·042	615·7	1108·26
104	40	0·072	618·7	1113·66
122	50	0·121	621·7	1119·06
140	60	0·196	624·8	1124·64
158	70	0·306	627·8	1130·04
176	80	0·466	630·9	1135·62
194	90	0·691	633·9	1141·02
212	100	1·000	637·0	1146·60
230	110	1·415	640·0	1152·00
248	120	1·962	643·1	1157·58
266	130	2·671	646·1	1162·98
284	140	3·576	649·2	1168·56
302	150	4·712	652·2	1173·96
320	160	6·120	655·3	1179·54
338	170	7·844	658·3	1184·94
356	180	9·929	661·4	1190·52
374	190	12·425	664·4	1195·92
392	200	15·380	667·5	1201·50
410	210	18·848	670·5	1206·90
428	220	22·882	673·6	1212·48
446	230	27·535	676·6	1217·88

* Expressed in the number of pounds of water which they would heat from 0° to 1° Cent., and from 32° to 33° Fahr. (See p. 114.)

(To be Continued.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

An Explanation of one of the Phenomena of the Aurora Borealis.

BY C. CAMPBELL COOPER, M. D.

The localities where favorable opportunities occur for observing auroral exhibitions, are so remote from the ordinary haunts of science, and their climate is so inhospitable, that it is only by some rare chance, or at the expense of great personal inconvenience, that any satisfactory observations can be made; and we are thus left ignorant of the real nature of the immediate aurora of the magnetic pole. But I am inclined to think that part of the phenomenon, as exhibited in our latitudes, is susceptible of explanation.

The universal testimony of those who have visited the more northern latitudes is, that the aurora is far more frequent there than with us. Now, as the origin of the light is always in or near the magnetic pole, there is reason to believe that its extension to more southern latitudes is owing to some peculiar condition of the atmosphere in those latitudes. Biot fancied there were clouds of fine metallic particles conducting the electric discharge from the north; but Becquerel answered that metal had never been discovered in the atmosphere except in some combination unfit for conduction, and the question has since rested. Of the phenomena as they appear to us, none are constant or uniform. But there are certain conditions under which two of them present themselves, which I believe are invariable. The aurora of our latitudes, whatever other phenomena they exhibit, consist principally of rays shooting up from various points in the north-west, north, and occasionally the north-east horizon. These rays, converging towards the zenith, stop short of that point, say 30° or 40°, forming thus a truncated cone or pyramid, whose base is the northern horizon. Sometimes these rays are continued to the zenith, completing the superior part of the cone. The apex, however, is never well defined, but seems intercepted from view by the corona, or a confused irregular circle of illuminated cloud. Now the invariable conditions are, the direction and point of convergence of these rays. Whenever the columns and corona are seen, the former always converge to the latter, whose apparent place is in or near the zenith of the observer. Now as the same cone of rays and corona exhibit, at the same time, like respective positions to different observers at distant places, it follows necessarily that they are reflexions or refractions of another light, at some surface capable of these effects in the upper strata of the atmosphere. This may be confidently asserted, since the aurora has been shown to be confined to our atmosphere, and therefore cannot be so far distant as to be devoid of parallax. There is no other conceivable mode of explanation for this uniformity of condition, than to suppose the cone and corona to be made up of reflected or refracted rays.

How the original light about the magnetic pole is produced, is not answered by even a plausible conjecture. All that we certainly know is, that it originates immediately at, or very near, that locality; is brilliant beyond any experience of our latitudes, is attended sometimes with magnetic disturbances, and is confined to, or at least has place within, the terrestrial atmosphere. The first and last of these alone concern us at present,

as showing the locality of the light reflected or refracted to us to be in the centre of Northern America, at latitude 72° nearly.

The question then occurs, in what way is a reflecting or refracting surface created in the upper air, by which the light can be turned to us. If no other answer presented, we might suppose the upper surface of the aërial ocean to be well defined as the surface of the sea, and the rays of light falling upon it from any source within the atmosphere, to be subjected to internal reflexion, as from any surface separating two media of different densities. But there is evidence that the auroral appearances are more variable in their altitudes than such a reflecting surface would be.

It is certain that the evaporation from the surface of the earth, and the other causes affecting the density of the atmosphere, are frequently so uniform in their action over a large space as to produce strata of such regular variation in density, that images of terrestrial objects are painted with surprising distinctness in the air at a considerable elevation above the real objects. The numerous instances of *unusual refraction* recorded by different observers, are all proofs of this. So extensive, sometimes, is this regularity, (as in the celebrated *fata morgana* of the Straits of Messina,) that a spectator on an eminence in the city, sees on a neighboring sea, "numberless series of pilasters, arches, castles well delineated, regular columns, lofty towers, superb palaces with balconies and windows, villages and trees, plains with herds and flocks, armies of men on foot and on horseback, all passing rapidly in succession on the surface of the sea." The well-known phenomenon of the *mirage*, observed by the French in Egypt, is ascribed by M. Monge to an extended surface of reflection marking the division of two strata of air of different densities.

With such instances before us, of the occasional and even frequent occurrence of the formation of widely extended surfaces in the atmosphere, capable of very regular reflexion, there is no difficulty in supposing such a surface to be sometimes formed in the upper air, and extending over many degrees both of latitude and longitude. In the absence of high winds this might readily occur by one of those sudden changes of temperature, which we have reason to believe take place in the higher strata of the atmosphere, affecting a considerable space.

That such surfaces are formed on a more limited scale, and are accompanied with such reflexions as the columns of our auroræ present, I myself have witnessed on three occasions. Some years since, I observed one evening, about seven o'clock, from a north window of a house in the eastern part of the city, a broad ray of light suddenly shoot up from a point a little west of north, extend itself nearly to the zenith, and occupy about 40° of the meridian. The sky had been gradually overclouded during the day, and the night was unusually dark. I watched the ray for some minutes, until it slowly faded away like the auroral beams, and immediately thereafter rain fell. Although the usual atmospheric conditions for an aurora were not present, I had no doubt the single ray was of that origin, from its direction, and the manner of its appearance and disappearance. Some months after, from the same window, I observed a like phenomenon, the atmospheric conditions being also very similar. I mistrusted then its auroral origin, and ascending to a higher point, discovered the ray to be a lengthened reflection of a light from a furnace chimney in the northern

part of the city. The analogy to the aurora impressed me at the time very forcibly, and frequently has since, until a recent observation of the same kind convinced me of the causes being similar in the two cases. Returning to the city with a friend, about eight o'clock one evening recently, I suddenly noticed a broad ray in the clouded atmosphere above us, having the appearance and extent of those just mentioned. When I first observed it, I was near the intersection of the line of Schuylkill Eighth street and the Ridge Road. It proceeded from a point nearly due south, and immediately above a light from the chimney of a factory or furnace in that direction, and stretched nearly to the zenith. I watched the ray as we proceeded along the Road as far as the intersection of Broad street. During all this time the bearing of the ray was changing with our position, until at Broad street, it ranged from south-west, or somewhat west of south, to the zenith. Below Broad street, our view of it was interrupted by blocks of houses.

We have only to consider these furnace lights to be immensely increased and at latitude 72° N.; and the reflecting surface to be formed somewhat higher and on a greater scale, by the same natural causes, and we shall see an exemplification of the aurora, and read part of its riddle.

It is worthy of note, that portions of these reflecting and refracting surfaces and media are so suddenly formed and dissolved, that Dr. Vince expressly likened the rapid appearance and disappearance of parts of a phantom ship, which he saw, to the shooting of auroral rays, although he seem to have had no idea of their causes being similar.

Notice of the Trigonometrical Survey of London.

The last piece of scaffolding built for the purpose of enabling the Sappers and Miners to make a trigonometrical survey of the metropolis and surrounding counties, has been moved from the gallery above the dome of St. Paul's. Although the scaffold was only up three months, the observations taken were between 3,000 and 4,000, in which were included every division in the degree. In many instances the same subject was gone over as many as six times—none less than three or four. The utmost distance obtained was 26 miles in the circle, with the exception of the north-west point; here Highgate Hill impeded the observations, the crown of the hill being higher than the level from which the observations were taken. With this single exception, no difficulties presented themselves, and the survey and the various altitudes obtained are of the most satisfactory description. In the language of the parties engaged, the metropolis and the surrounding counties may be considered nearly a level plain. Although below it was repeatedly misty, the atmosphere was exceedingly clear above,—which enabled the Sappers and Miners repeatedly to obtain the utmost limit of their survey. The extreme height of the scaffolding, from the base to the crown, upon which the observatory was built, was 91 feet, and it took between a fortnight and three weeks in raisiug. As the whole was bound together with ropes, about half a ton was used for the purpose. It may be gratifying to know that in this perilous undertaking not the slightest accident—not even to the breaking of a single pane of glass—occurred, while

only some of the corners of the planks were chipped off during the removal. The most dangerous part of the work was the fixing of the poles which supported the cradle immediately beneath the principal dome.—These extended beyond the gallery 35 feet, and great skill and caution were requisite in fixing as well as in removing them; for had the slightest slip occurred, no power could have prevented them falling through into the church. During the period the scaffold was up, the lead work of the upper dome was repaired. London Athenæum, Nov. 1848.

Description of a Lunar Rainbow. By J. F. W. Herschel.

Yesterday evening at 6h. 40m. P. M., I had the gratification of witnessing, for the first time, the rare and beautiful phenomenon of a lunar rainbow in all its perfection. The moon, (full on the 11th, at 1h. 30m. A. M.,) was near the eastern horizon, shining brilliantly through a considerable clear opening in the otherwise generally and densely clouded sky. A light, drizzling, and very uniform rain was falling with a gentle wind from the N. E. The arch, very nearly a semi-circle, was perfect in every part; apparently much better defined and somewhat narrower than the solar rainbow, (circumstances easily accounted for.) Its span also appeared somewhat less, which of course was only an illusion. Though much brighter than I could have expected a lunar rainbow to appear, (the effect, no doubt, of the very dark background of cloud against which it was projected,) it exhibited scarcely any color: barely enough to assure the spectators that the *order* of color was as in the solar bow—a faint ruddy tinge being sensible on the outer, and a still fainter bluish hue on the inner side;—affording a striking illustration of that singular law in the physiology of vision, that the perception of color is not developed unless under a certain amount of the stimulus of light. For example, colors are not distinguishable in the prismatic spectrum formed by the light of putrescent shell-fish or rotten wood.

Not only was the primary bow thus fully developed. The exterior or secondary rainbow was also visible; not indeed conspicuously, so as to attract attention unlooked for, but quite unequivocally, and at its proper distance from the primary. To become sensible of its existence, it was necessary to *keep the eye wandering*. Neither were traces wanting of the supernumerary arcs which form so conspicuous an appendage to the inner edge of the solar rainbow in certain contingencies. They were indicated by a perceptible streakiness fringing the internal border of the arc, though to say whether more than one streak existed was not possible.

The southern leg of this fine arch was evidently formed within a few hundred yards of our station; as, on ascending to the roof of my dwelling house, it was seen on the hither side of some trees at that distance. When first seen it was perfect, and continued so for six or eight minutes, when clouds obscuring the moon put an end to it. I will only add further, that the impression produced by the spectacle was of that peculiar, solemn, and unearthly kind which, once experienced, remains ever after ineffaceable. Ibid.

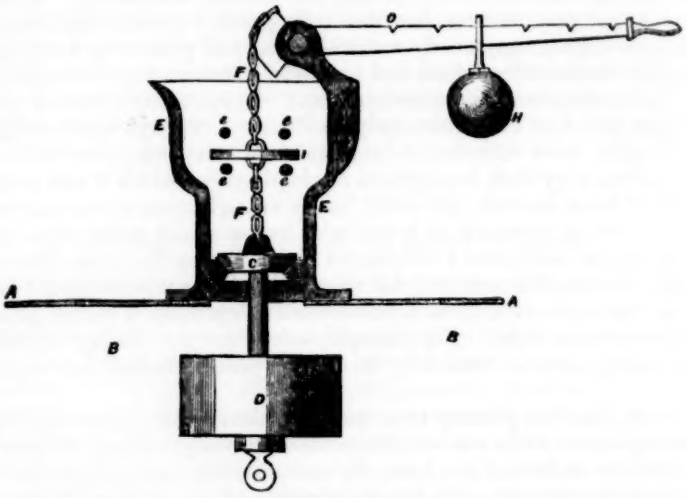
Improved Safety Valves. By Alfred Gregory, Esq., C. E.

From the London Mechanics' Magazine, for November, 1848.

I have invented an improved form of safety valve for steam boilers, which has met with the approbation of several eminent engineers. I am desirous of giving it publicity, and for that purpose respectfully submit the accompanying sketches and description, for insertion in an early number of the Mechanics' Magazine.

The advantages do not require to be much insisted on. The practice of overloading the safety valve is much more common than is generally supposed: sometimes it is the act of *ignorance*, but most frequently that of *will*, not only endangering life, but injuring the *pocket* also, in the destruction (which is very serious) that ensues to the *boilers*, *fire-boxes*, &c. The number of fines levied on locomotive engine-men furnishes sufficient evidence of the frequency of its occurrence.

Fig. 1.



Description.

Fig. 1, represents the safety valve in a form appropriate for stationary use.

Fig. 2, another modification, on the same principle, applicable to boilers of every description, locomotive, marine, and stationary.

Fig. 1, AA, represent the top plates of boiler; BB, the steam space inside; C, the ordinary conical valve, having a perpendicular spindle, to which a weight, D, is attached; EE, valve-box; FF, a chain, which is connected to the valve at one end, and at its other end to the short curved part of the lever, H, is a regulating weight; I, a shield to protect the valve from injury or interference; *e*, *e*, *e*, *e*, four bars or stops to the shield I, for frustrating any attempt to damage the valve.

The mode of working is, for the steam to raise the valve, as usual, when

its pressure exceeds that of the weight, D, less the lifting power of the lever, G, and the weight, H. The weight, D, being inside the boiler, cannot be for any mischievous purpose got at; and it is equal to the *extreme* pressure allowed upon the boiler, or may be made so, by hanging weights to the eye-loop of D, which additional weights may be reduced, or altogether removed, as the boiler deteriorates by wear. For any *less* pressure, according to the working necessities of the engine, the engineer has the same control over the valve as at present, by sliding the weight, H, on the lever, G, which operates in taking off weight; *regulating the reduction* as he pleases; but he cannot increase the load upon the valve beyond what the weight, D, inside the boiler, gives; for, if hanging more weight on the lever, G, he takes off instead of increasing pressure; and, on the other hand, if raising the handle end of the lever, it has no effect upon the valve on account of the connecting medium being *a chain*, which, of course, can only operate in one way, hanging loose, as it does, and throwing no stress upon the valve when moving downwards.

Fig. 2.

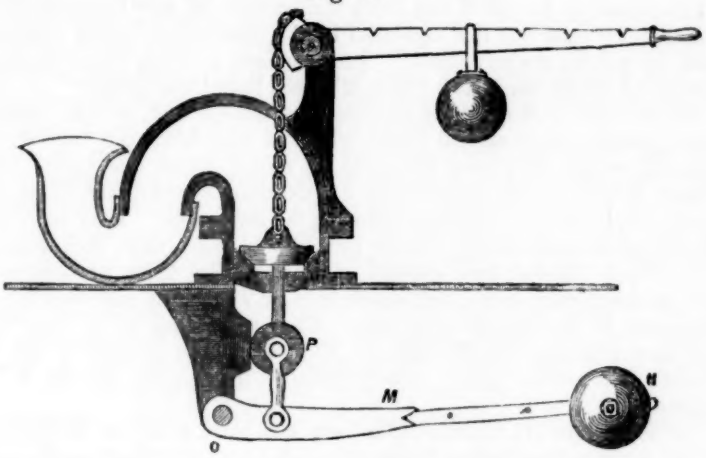


Fig. 2 is another form, involving the same action, but instead of the heavy weight attached to the valve-spindle, as before, there is, inside the boiler, a lever, M, having a weight, N, and fulcrum at O, equal in its effect to the extreme pressure allowed, and which may be reduced as the boiler, by use, weakens, by fixing the weight, N, nearer the fulcrum, convenience for which is shown. Instead, also, of the protecting shield, as in No. 1, the blow-away steam is here carried off by a double U-bent pipe, the accessible half of which is made of thin sheet copper, strong enough to carry away the steam as it blows freely into the air, there being then little or no pressure; but if the steam be confined within it, through any wilful attempt to plug the pipe up, the copper will *rend*, (a result peculiar to that metal,) and permit the necessary escape. There is likewise shown a small roller, P, to counteract the curvilineal action of the lever M, and keep the valve-spindle from "sticking." But both this and the copper

pipe are precautions no more necessary than at present with the best constructed valves, and might safely be dispensed with. The remaining parts and action of figure 2 are the same as figure 1.

Both plans represent the principle of a valve, the mechanical arrangement of which, however modified, embraces every advantage as to security, of a "*locked valve*," in frustrating any attempt to overload it, either by accident or design, through ignorance or will, without the usual attendant disadvantages of inconvenience, expense, &c., of a second valve, and liability to "*stick*" by corrosion of parts through *standing long unused*, &c.; a liability which the present form has not, as it is the engineers' *frequent* "*working*" safety valve, which is a *locked* and limited one, but possessing all the facility of regulating his pressure that he has now, though not allowed to exceed the fixed *extreme* safe point.

On the Duration of a Solar Spot.

BY W. PRINGLE, ESQ.

It is stated by Dr. Dick and other writers that "no spot has been known to last longer than one that appeared in the year 1676, which continued upon the sun for seventy days." I am inclined to think that a large spot now going off the sun's disk (Nov. 21), has lasted still longer.

On the 19th of August last I observed a double spot, or two adjacent spots, near the sun's eastern verge, which as they advanced increased in size, and on the 23rd were visible to the naked eye as one spot. Their longest diameters were 27,000 and 31,000 miles respectively, being each about a third less in breadth, embracing the penumbræ. They were about 10,000 miles apart, though for the first two or three days they appeared to be linked together by a curved chain of minute spots or shallows at their northern extremities, but which became eventually absorbed into the penumbræ of the largest of the two. They were both of an oval form, and were followed till the 28th or 29th, when the nucleus of one had divided into several parts. They probably disappeared on the 31st of August.

On September 16, I remarked a large spot (at 4 P. M.) so far advanced on the sun's eastern limb as distinctly to exhibit several black nuclei within the edges of the penumbræ, but no great nucleus in the centre; and on the 17th, when it had come more round, this peculiarity became more apparent, the interior sides being studded with small dark spots, while the centre showed nothing but one vast clouded space or shallow. As I had been looking for the re-appearance of the two spots of August, it occurred to me that they might have become conjoined, the conjunction of the two penumbræ forming the central space of the spot now advancing. There being no other traces of them, I conceived I was justified in this conclusion. The smooth contour of the two oval spots had become since the contact a vast irregular polygon, as if by the concussion of two forces the penumbræ had been dashed or shaken into angular protrusions. The entire spot on the 17th measured about 50,000 miles in its longest dimensions. A very fair engraving of its outline appeared in the Illustrated London News of October 7th. Its size on the 21st was estimated at 60,000 miles: I made it somewhat more afterwards. It was quite percep-

tible to the naked eye for nearly a week after the 17th. On the 27th it was about half a digit from the sun's western margin, and probably disappeared the day after; but cloudy weather prevented it being followed.

About a fortnight afterwards, on the 13th of October, I descried a long lenticular-shaped spot about a quarter of a digit advanced on the sun's eastern limb. This I had little doubt was the spot on its return; and, as it came on, the general resemblance confirmed its identity. It was, however, much contracted in dimensions, measuring about 44,000 miles when near the sun's centre. The irregular pointed outline was still prominent, though the projections were less than on its previous appearance.

On the 26th of October, I saw it as a very dim dot or line, scarcely distinguishable from the line of circumference of the sun's western limb.

On the 9th of November, at some distance north of the point of Mercury's entering the disk, a faint depression, having the appearance of a spot of some size, was visible. This being the very time when the spot of October might be expected to return, I felt confident it was the same; and its further progress confirmed the identity. It was again contracted much in size, being somewhat triangular in shape.

If the inferences above stated be well founded, the spot will have lasted about ninety-five days. Whether it will yet make another revolution, or half a one, remains to be seen; but I shall not probably have it in my power to make observations at the period of its next appearance. It may be looked for on the 4th or 5th of December.

In many respects this spot was a remarkable one, and in all likelihood did not escape the observation of the illustrious author of the Cape Observations, whose chapter on solar spots is so interesting.

I should be happy if you think this worth noticing in your journal as a report of some particulars to which my attention was directed, and which more profound observers may have overlooked.

The opinion of Dr. Dick, author of The Sidereal Heavens, &c., to whom I submitted the observations of August, September, and October, that in all probability the spots were identical, according to the grounds stated, has the more emboldened me to address you.

Edinburgh, Nov. 21, 1848. Lond., Edin., & Dub. Phil. Mag., Dec., 1848.

On a Simple and Ready Way of Producing Tools for Grinding Lenses.

BY N. S. HEINEKEN.

If you think the following simple and ready way of producing tools for grinding lenses likely to be of service to any of the readers of the Philosophical Magazine, you will oblige me by making it known. I was led to employ this method in consequence of an injury done to a lens, for the re-grinding of which I had no corresponding brass tool. Rather than take the trouble of making a set of brass gauges and also a set of grinding-tools, I took a cast of the *lens itself* by pressure upon the cooling surface of some fusible metal contained in a frame of card. On this tool, thus readily formed, I re-ground and polished the lens; and where great accuracy of figure is not required, have found the method to answer very well. Hoping

that this plan may be useful to others who may meet with a similar casualty, I communicate it. Perhaps I may also be allowed to mention, that I have found zinc exceedingly useful for the formation of ordinary grinding-tools, being readily cast and turned; and though not equal to brass, yet being in many respects superior to the soft metal tools sometimes employed.

Sidmouth, Nov. 15, 1848. Ibid.

Magnetic and Meteorological Observations made at the Royal Observatory, Greenwich, in 1846.

The increasing interest evinced in the sciences of Magnetism and Meteorology leads us to give a brief abstract of the salient features in the volume at the head of this article:—which, from its expensive nature and limited circulation, is not likely to be seen by our readers generally.

The magnetical and meteorological departments of our Royal Observatory have, under the superintendence and management of Mr. Airy, attained a degree of excellence that entitles the observations to be regarded as worthy of high credit. The instruments employed are of the best possible construction,—and the observers are compelled to observe with mechanical regularity.

"In order," says Mr. Airy, "to give reasonable security to myself that the assistants have really been present at the time at which their observations profess to have been made, there is provided an instrument denominated the watchman's clock. It consists of a pendulum clock which has no hands, but of which the dial plate turns round; this dial plate has a number of radial pins fixed to its circumference, each of which can be pressed downwards (being held by the friction of a spring only) without disturbing the others. A lever is attached to the clock frame in such a position, that by means of a cord which passes from the lever through a hole in the clock-case to its outside, the lever can be made to press down that pin which happens to be uppermost and no other. The clock-case and clock face are securely locked up. Thus the only power which an assistant possesses over the clock is that of pulling the cord and thereby depressing one pin; the dial plate then turns away, carrying that pin in its depressed state, and thus retains for about eleven hours the register of every time at which the assistant has pulled the cord. About one hour before returning to the same time (semi-diurnal reckoning), the bases of the pins begin to run upon a spiral inclined plane, by which they are forced up to their normal position before coming to that point at which the lever can act on them. It is the duty of each assistant, on making the prescribed observations, to pull the cord of the watchman's clock; and it is the duty of the first assistant to examine the face of the clock every morning, and to enter in a book an account of the pins which he finds depressed."

The instruments used in 1846, were,—for magnetism, a declination magnet, a horizontal force magnet, a vertical force magnet, a dipping needle; for meteorology, a standard barometer, dry and wet bulb and radiation thermometers, hygrometers, anemometers, rain gauges, actinometers. The electrical apparatus consisted of electrometers, galvanometers, a spark measurer, and a dry pile apparatus.—We proceed to give the most impor-

tant results. The diurnal range of the declination magnet was smallest in January and largest in September. The diurnal range in summer was 15′ 14″, in winter 11′ 53″, and for the year 13′ 34″. The diurnal range of the horizontal force magnet was largest in August and smallest in January. The diurnal range in summer was 0·004511, in winter 0·002688, and for the year 0·003600. The diurnal range of the vertical force magnet was smallest in January, February, and December, and largest in September. The diurnal range in summer was 0·001817 of the whole vertical force, in winter 0·001108, and for the yesr 0·001132. The mean magnetic dip for the year 1846, at 21 ^{h}, was 68° 58′-6, and at 3 ^{h}, 68° 57′-6.

The mean height of the barometer in each month, deduced from two-hourly observations, was as follows:—January 29·671, February 29·849, March 29·655, April 29·589, May 29·779, June 29·866, July 29·757, August 29·777, September 29·824, October 29·516, November 29·821, December 29,697. The mean of all the monthly results is 29·733.—Several tables are given illustrative of the influence of the moon on the barometer; from which is deduced that when the moon was at or near her mean distance and going from the earth, the mean height of the barometer was the greatest. The mean height of the barometer at or near new moon was 29,6160, at or near first quarter 29·7529, at or near full moon 29·8100, at or near third quarter 29·7254. It would seem, therefore, that the mean pressure of the atmosphere was greatest when the moon was about fourteen days old. The mean temperature in 1846 was:—in January 43°8, February 44°2, March 44°9, April 49°1, May 57°1, June 67°8, July 67°2, August 65°5, September 61°7, October 51°6, November 45°2, December 32°6; and the mean of the year 52°5. The mean temperature of the dew point was—in spring 42·9, summer 56·7, autumn 48·4, winter 36·7, and the year 46·2. The mean degree of humidity in spring was 0·833, in summer 0·798, in autumn 0·884, in winter 0·894, and in the year 0·852. The mean weight of a cubic foot of air was 534·6 grains. The prevailing wind during the year was S.W., and the next in order of magnitude were S.S.W.; W.S.W., N.N.W., and S. The amount of rain collected in each month by Osler's Anemometer, at 205 ft. 6 in. above the level of the sea was:—in January 0·85 in., February 0·67, March 0·20, April 1·81, May 0·95, June 0·36, July 1·14, August 2·98, September 0·98, October 2·43, November 0·66, December 0·43, and during the year 13·46. By the rain gauge, 177 feet above the sea, 22·63 inches were collected; by that 155 feet above the sea, 25·29 in.; and by that 35 feet above the sea, 24·37 in.—We may add that all these results are deduced from two-hourly observations made day and night.

London Athenæum, November, 1848.

Notice of Mr. Lassell's Telescope.

Referring to your notice, in the *Athenæum* of the 14th of Oct., of the simultaneous discovery of the 8th satellite of Saturn, on the 18th of Sept. last, by Mr. Lassell in Liverpool and by Mr. Bond in the United States,—it may perhaps be interesting to some of your readers to know that the telescope with which Mr. Lassell has made this admirable discovery *was constructed by himself*, while that employed by Mr. Bond came from the

celebrated establishment of Mertz & Son, of Munich, and cost, I believe, upwards of £3000. Having had the good fortune to be an eye-witness to the progress of Mr. Lassell's telescope from the commencement, I can bear testimony to the almost unparalleled personal labor and exertion with which he has dedicated every leisure hour to the construction of his noble instrument, from his earnest devotion to and disinterested love for astronomical science. Among the many feats which Mr. Lassel has already performed with this "*home-made*" telescope, I may particularize the discovery of the satellite and ring of the new planet Neptune; also upwards of eleven perfect observations of the 7th satellite of Saturn—which had, as it were, been lost to observers for nearly thirty years.—I am, &c.

Patricroft, near Manchester, Oct. 25th. JAMES NASMYTH.

We have received from Mr. Lassell the following qualification of the honors assigned to him by Mr. Nasmyth when speaking of his "home-made telescope" in our paper of last week. "I have nowhere asserted that I have discovered a ring of Neptune. I have indeed stated my belief in its existence, because I could not account for all that I have seen about the planet on any other hypothesis; but to verify it absolutely as a discovery has hitherto been beyond my powers. I doubt, moreover, whether I have had so many as eleven undoubted observations of the closest satellite of Saturn; though I have had a sufficient number to corroborate the period of revolution given by Sir W. Herschel." Ibid.

Description of the Method of Forming Chinese Balls.

In the last number of the *Athenæum* is a notice, extracted from the *Builder*, of a supposed discovery of the method of forming Chinese balls, founded upon the cleavage of the balls caused by the application of heat and steam. Upon this I have to remark,—first, that, in a substance which is not totally free from *grain* or lamination, the production of a very regular cleavage by heat and steam is no proof that the surfaces have ever been separated before; and secondly, that there is no necessity for the supposition that the balls have been made in parts:—as I now proceed to show.

In all the Chinese balls it will be remarked that a large proportion of each of the inner shells is removed by large circular holes. Into each of these holes a tool may be introduced in form like the letter L; the stout stalk or upright stroke of the L (which may be of any length) being intended only for the convenience of holding, and the thin horizontal stroke of the L (which is the cutting part of the tool) being slightly bent downwards for the curvature of the spherical shell, and being determined in length only by the diameter of the hole into which it is introduced. The ball then being mounted on a lathe, it is evident that by means of this tool the shell may be undercut on all sides to an extent equal to the free length of the tool, or nearly equal to the diameter of the hole. Thus, if there were a hole one inch in diameter, a tool might be introduced whose whole length (corresponding to the thin stroke of the L) is one inch, and whose free length is perhaps $\frac{7}{8}$ of an inch: and by means of this the shell will be

undercut in a circle whose diameter is $1\frac{3}{4}$ inches. If, then, the holes are so near to each other that the large circles thus cut will cover the whole surface, the inner ball will be completely detached from the exterior shell.

I lately examined a Chinese ball in which there were at first sight visible externally only three large holes. But upon closer examination it was discovered that there were a number of holes of the same size plugged up. Luckily, the external shell had been injured by a violent blow; and I was thus enabled to examine with the utmost accuracy the nature of the plugging. In one part a plug had been broken away and lost, leaving visible the ring into which it had been inserted; in another part the ring was partly broken away, leaving the edge of the plug visible.—The plugs are screwed into the rings, with the most strongly cut screw that I have ever seen,—the depth of the thread exceeding the interval between two threads. (The Chinese must be possessed of good screw-cutting tools and of great skill in the use of them.) The plug has a flat brim or verge, so that it is screwed down to a shoulder-bearing.

Upon examining the ball in detail, I found eleven holes thus plugged up—making in all fourteen holes. Then, upon actually measuring the diameters of these holes and the distances between adjacent holes, I found that all parts of the sphere were abundantly covered by the circles which could be undercut by the use of such a tool as I have described. As far as I could discover, the holes in the inner shells corresponded to those on the outer shell, in position and in proportion of their diameters to the diameters of their spheres; and thus each of these spherical shells could be undercut in the same manner for detaching the sphere within it,—each shell, for the most part, requiring a different tool. The process, then, by which Chinese balls *may be* made, and by which I conceive they *have been* made, is the following:—

1. The block of ivory is turned to a spherical form.

2. A number of conical holes are drilled into the sphere, the vertices of the cones being at the centre of the sphere and the centres of the bases of the cones being in any symmetrical arrangement which will bring the holes near enough together. At the same time any part of the tracery work which is common to all the shells is drilled nearly to the centre.

3. A set of tools of the form of the letter L is prepared, one for each shell; the length of the stalk and its stop being adapted to the distance of that shell from the exterior, and the length of the cutting part being nearly equal to the diameter of the conical hole on that shell.

4. The perforated sphere is chucked upon a common lathe,—the chuck being conical, adapted to any of the conical holes. The tool with the longest stalk is introduced into the hole opposite to the chuck (being supported on a cross-rest), and the innermost sphere is undercut, so as to detach in part the central block. The sphere is then chucked by another hole, and the process is repeated; till, after the last undercutting, the central block is completely detached.

5. In like manner the second shell (measuring from the centre) is undercut by the use of another tool,—until the first shell is completely separated both from the central block (by the former operation) and from the second shell (by this operation). Then, the tracery of the first shell is cut: the drills and other cutting instruments being introduced through the large

holes, and the first shell being turned about so as successively to expose all parts of its surface.

6. After this, each shell successively from the centre to the exterior is detached in the same manner, and its tracery is cut.

7. Possibly it may be advantageous for the steadiness of the support on the chuck, to block some of the holes not occupied in the turning process, each by a conical block. Or a ring support may act in the inside of the external hole opposite to the chuck.

8. The final operation, after undercutting the external shell and cutting the tracery of the shell next to it, will be to plug as many holes as may be thought necessary, and to cut the tracery upon the whole external shell.

Greenwich, October 11. A. B. G.

Ibid. Oct. 1848.

Report on the Air and Water of Towns.

BY DR. SMITH.

In commencing his report, the author says, it has long been believed that the air and the water have the most important influence on our own health,—and superstitions have therefore constantly attached themselves to receptacles of the one and emanations of the other. The town has always been found to differ from the country: this general feeling is a more decisive experiment than any that can be made in a laboratory. The author proceeds to examine all the sources from which the air or the water can be contaminated. The various manufactures of large towns, the necessary conditions to which the inhabitants are subjected, and the deteriorating influences of man himself are explained. If air be passed through water a certain amount of the organic matter poured off from the lungs is to be detected in it. By continuing this experiment for three months, Dr, Smith detected sulphuric acid, chlorine, and a substance resembling impure albumen. These substances are constantly being condensed upon cold bodies, and in a warm atmosphere the albuminous matter very soon putrifies and emits disagreeable odors. The changes which this substance undergoes by oxidation, &c., are next examined,—and shown to give rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably other gases. The ammonia generated fortunately from the same sources as the sulphuretted hydrogen materially modifies its influences. The consequences of the varying pressure of the atmosphere have been observed; and it is shown that the exhalations of sewers, &c., are poured out in abundance from every outlet when the barometric pressure is lowered. By collecting the moisture of a crowded room by means of cold glasses, and also dew in the open air, it was found that one was thick, oily, and smelling of perspiration, capable of decomposition and production of animalcules and confervæ,—but the dew beautifully clear and limpid. Large quantities of rain-water have frequently been collected and examined by Dr. Smith; and he says,—I am now satisfied that dust really comes down with the purest rain, and that it is simply coal ashes. No doubt this accounts for the quantity of sulphites and chlorides in the rain, and for the soot, which are the chief ingredients. The rain is also often alkaline,—arising pro-

bably from the ammonia of the burnt coal, which is no doubt a valuable agent for neutralizing the sulphuric acid so often found. The rain water of Manchester is about $2\frac{1}{4}^{\circ}$ of hardness,—harder, in fact, than the water from the neighboring hills which the town intends to use. This can only arise from the ingredients obtained in the town atmosphere. But the most curious point is the fact that organic matter is never absent, although the rain be continued for whole days. The state of the air is closely connected with that of the water; what the air contains the water may absorb, what the water has dissolved or absorbed it may give out to the air. The enormous quantity of impure matter filtering from all parts of a large town into its many natural and artificial outlets, does at first view present us with a terrible picture of our underground sources of water. But when we examine the soil of a town we do not find the state of matters to present that exaggerated character which we might suppose. The sand of the Chelsea Waterworks contains only 1·43 per cent. of organic matter after being used for weeks. In 1827, Liebig found nitrates in twelve wells in Giessen, but none in wells two or three hundred yards from the town. Dr. Smith has examined thirty wells in Manchester, and he finds nitrates in them all. Many contained a surprising quantity and were very nauseous. The examination of various wells in the metropolis showed the constant formation of nitric acid; and in many wells an enormous quantity was detected. It was discovered that all organic matter, in filtrating through the soil, was very rapidly oxidized. The presence of the nitrates in the London water prevents the formation of any vegetable matter,—no vegetation can be detected, even by a microscope, after a long period. The Thames water has been examined from near its source to the metropolis, and an increasing amount of impurity detected. In the summary to this Report, Dr. Smith states that the pollution of air in crowded rooms is really owing to organic matter and not merely carbonic acid,—that all the water of great towns contains organic matter,—that water purifies itself from organic matter in various ways, but particularly by converting it into nitrates,—that water can never stand long with advantage unless on a large scale, and should be used when collected or as soon as filtered.

Ibid., Aug. 1848.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Contributions towards a History of the Useful Arts—Weaving and Spinning.

BY THOMAS EWBANK, ESQ.

Power Looms.—"In Dantzick in Poland there was set up a rare invention for weaving four or five webs at a time without any human help. It was an Automaton or Engine that moved of itself and would work night and day: which invention was supprest because it would prejudice the poor people of the town; and the artificer was made away secretly, (as 'tis conceived,) as Lancellotti the Italian Abbot relates out of the mouth of one Mr. Muller, a Polonian who had seen the device."—*Humane Industry: Lond.* 1661. A little volume ascribed by Anthony A. Wood to Dr. Thos. Powell, who died in 1660.

Spinning.—To supersede the primitive process of twisting the fibres of

a single thread with the fingers of one hand, and holding a distaff in the other, by devices more creditable to the Goddess of Wisdom, was repeatedly attemped in the 17th century, if not before; but society had not sufficiently matured to appreciate, improve, and adopt them. Branca, in the 20th Figure of his book, *(Le Machine: Rome*, 1629,*)* has a spindle turned by water on the principle of Barker's Mill,* and a female sitting by, supplying material from a distaff. Similar first thoughts are met with in other authors.

Subjoined is a long article headed *Filatoio D' Acqua*—Spinning Thread by Water Power—from a scarce Italian volume entitled "*Novo Teatro di Machine et Edificii;* per varie et sicure operationi, co' le boro figure tagliate in rame é la dichiaratione e dimostratione di ciascuna. Opera necessaria ad architetti, et a quelli di tale studio si dilettano. Di *Vittorio Zonca*, architetto d'ella Magnifico Communita di Padoua: 1656." This New Theatre of Machines is a small folio of 115 pages, with coarse copper-plate illustrations. The collection is very similar to that of Branca, and others of the same century. Supposing the article to be the oldest extant on the subject, I have thought it worth preserving. Two engravings accompany it; the first represents a water wheel, with shafts, cog wheels, and trundles, outside of a building, to drive the spindles, &c., within; as the connexion with the latter is not shown, it possesses nothing of interest. The second is copied below entire, except that a frame or "Jenny;" precisely like the one figured on a first floor, is not repeated on the second. The frames are arranged octagonally to contain 48 spindles in each.

Spinning Thread by Water Power.

Most beautiful, as well as wonderful, is the structure of the water power Spinning Machine: for one observes in it so many movements of wheels, spindles, small wheels and other contrivances, horizontally, perpendicularly, and diagonally, that the eye becomes confused with the thought, how human ingenuity could have conceived such a variety of objects, of such diverse movements, driven by a single wheel whose motive power is inanimate.

These machines not only spin the silk, that is, wind it around the reels, but they twist it more or less as may be needful, whether for working or for weaving silk cloth—

Firstly, The strong motive power of this machine is running water, which is enclosed within a canal with its gate, and enlarged by opening thereof, as is usually done in undershot mills, thus giving motion to the wheel. This the larger it is the more suitable will it be; and of the buckets or floats which surround the wheel, as in the other case, at least four should dip in the water. Moreover, it is necessary to observe whether the stream runs from the right side, or from the left, for the machine can not, in every locality, be driven from the right side, and the teeth of the spur wheel, which is on the same shaft with the water wheel, and parallel to it, are to be placed accordingly, either outwardly towards the water

* Two pipes wound spirally round a vertical cylinder, and the fluid discharged at tangents. The principle was not novel in Branca's time; hence the error of ascribing it to Dr. Barker, a century and a half later. He merely proposed its application to turn grist mills.

wheel, or inwardly towards the machinery—for it may turn in two different directions.

The canals should be well constructed, with their sides of very hard stones, joined together and well tied with iron cramps leaded, so that the water, by whatever vent it may escape, shall not be deprived of its force.

On the other end of the shaft of the water wheel is the spur wheel or shield, [*scudo,*] (which I have stated above to be parallel to it,) of forty teeth, which turns upon a perpendicular trundle of ten rounds; upon which trundle is another spur wheel of smaller dimensions than the first, placed transversely and having thirty-six teeth, which turns another trundle of nine rounds upon a shaft of iron placed above it transversely; but upon the other end of this shaft is another trundle of twelve rounds, which turns an indented wheel with one hundred and eight teeth on the inner side, towards the machine, around which are placed many pieces, and in the midst the arbor turning on its upper and lower pivots, and hence this machine is called a garland. [*ghirlanda.*] Now from the arbor extend, in the form of a star, eight arms transversely towards the wheel, and project a short distance beyond it, so that from their extremities may rise eight upright pieces called columns, [*colonelli,*] which meet, in the upper portion of the shaft, another wheel, similar to the lower one, with the same number of arms; and if the garland is very high, serving to drive two or more ranges of reels, another wheel of the same description will be necessary betwixt the two, having as many similar arms, so as to stiffen the uprights on account of their too great height. Around these uprights, other pieces, called serpents, [*serpi,*] are placed diagonally: that is with one end elevated, and the other end, to the left, depressed, and secured in their positions upon the columns. With the lower or left end they strike and drive upwards the spokes of the small wheels, between which the reels are placed, turning them towards us; at the same time the larger star revolves, driving in a contrary direction, towards the garland, the star below it, which holds in its centre the pivot of the reel.

There are also attached to the arbor of the said garland four transverse pieces, which extend beyond the pieces called serpents, and reach to the spindles of the bobbins; and the said transverse pieces have across their ends, transversely, another piece of a circular form, the outer face of which is covered with leather, so that, as they revolve with the arbor, they press against the spindles, turning them around. To the right end of each of these pieces is attached a cord, passing through a pulley on the arbor, and fastened to a weight of lead or stone, which holds always in one position the right end of the said piece, drawing it towards the centre of the garland, so that it shall not strike against the spindles, and at the same time pressing the left end of the said piece more firmly against the spindles; and these pieces are called by some, rubbers. [*stroffinazzi.*]

Moreover another spinning machine can be driven together with this, when the motive power is sufficiently strong; and it is to be done in this manner: In the midst of the garland must be placed another indented wheel, similar to the lower one, and both will revolve together;—and gearing into this a trundle on an iron shaft, having a trundle also at the other end, similar to the one below, which will drive at the same time, and in

the same direction, another spinning machine, in every respect similar to the first.

Now, the description of the garland being finished, it remains for us to examine the other portions of the machine which surround it, which by some are called open frames, [*varghi*,] each of which contains a range of reels and bobbins, and more or less of these ranges are made, according to the height of the place where the machine is put up. They are constructed in a circular form, each of the width necessary to hold one reel; for around the garland stand sixteen or eighteen columns, making as many open spaces, within which are placed the reels. To these columns, on the inner side next the garland, are fixed brackets or modillions, within which, for they are grooved, are small wheels with seven or eight projecting spurs or spokes, which are moved by the pieces called serpents, as I have already said; on the centre of these wheels are fixed star wheels of eighteen teeth, having beneath them other smaller star wheels of twelve teeth, in which are set the pivots of the reels;—whilst the wheels turn together with the larger star wheels, they drive likewise the smaller star wheels, together with the reels.

The number of wheels and reels is the same, for the brackets which sustain the wheels are alternated: that is, one bracket with its wheels and another without. These reels hold each six hanks of silk, and beneath them is a circular transverse piece, which passes from one column to the other, upon which is fastened a rod of glass; and beneath it, but upon the same piece, are certain iron instruments made in the form of the letter Z, called loops, [*canaletti*,] which guide by their middle grooves the silk thread, and pass it over the glass rod, so that it may not be broken, which would happen were it of other material, and it reaches finally the reel, around which it winds itself.

Besides these there are, lower down, other brackets on the inner side of the columns, next the garland, that support a flat plank, which passes round circularly with the circumference of the frames, and contain six holes, to place as many glass cups, within which revolve the spindles of the bobbins, which are of iron, lubricated with oil. If these cups were of iron, and not of glass, they would wear the spindle, which, as may be seen in the drawing, is of a round form and pointed at its foot; but that portion of it that passes through the holes in the bobbins is square, so that these are more firm as it moves or revolves. There is also a whorl of iron, which, by its weight, serves to prevent the bobbin from springing out of its place.

The spindles being prepared in this manner, there is placed a little above the glass cups, another plank cut into the form of a bridge, which supports square blocks secured on the inner side, and having a side opening on the part projecting beyond the bridge, in which are fixed the spindles by means of a small pin. These blocks, which are called boxes, should be placed at about half the height of the spindle. This being done, the bobbins, with the silk around them, are fixed upon the spindles and secured there; then upon the head of the spindle is placed a tinned cap, in the shape of a bell, with two arms of iron wire of a circular form, the upper one not rising above the middle of the cap, and the other or lower one not below the middle of the bobbin. In each arm there is an eye, and the silk thread, as it leaves the bobbin, passes through the eyes, and thence by the loop

and over the glass rod, directly to the reel above, around which it winds itself in six hanks, corresponding to the number of spindles.

It remains now to be seen in what manner the silk may be twisted, so that nothing may be wanting to the perfection of this machine. In the first place, I say, that when one wishes to twist the silk, it is done in this manner:—Outside the spindles is placed a circular belt of leather, two fingers in width, attached at one point to a bent iron bar, fixed upon one of the transverse pieces of the garland, which belt is kept in place by means of pins upon eight alternate columns out of the sixteen. But this belt should not, in all cases, be placed outside the spindles, for when, on account of the direction of the current of water, the spinning machine turns to the left, then the silk will be twisted by the rubbers, inside the spindles, and not by the circular belt outside; but if the machine turns to the right, then it must be done in the manner above mentioned, as I have said. The example in nature tallies with this; for when a woman spins, she twirls her spindle with the left hand, but when she twists the thread, she twirls it with her right hand.

The silk is twisted more or less, according to the various purposes for which it is wanted, in this manner:—The stars which are upon the centres of the small wheels, are taken off and replaced by larger ones, when it is desired to twist it very much, or by smaller ones when it is desired to twist it but little; for the stars may be taken off, or put on, by means of the iron pins fixed in the square collar, which is set into the middle of the small wheel, as may be clearly seen in the drawing.

Explanation of Plate I.

A. Bobbin with its cap.
L. Tinned cap with its flyers and eyes.
B. Spindle of the bobbin, of a square form.
C. Pulley or whorl of the Spindle.
D. Cup-shaped glass.
E. Block called a box, which holds, by means of a pin, the spindle.
F. Small wheel with eight spokes or spurs.
G. Star wheel fastened upon the above wheel, by means of certain iron pins, fixed in a square collar in its centre, which star wheel has eighteen teeth.
H. Smaller star wheel below the other, having twelve teeth, into the centre of which fits the pivot of the reel.
I. Bracket fixed on the inner side of the column.
K. Hole in the adjoining bracket, which supports the other end of the reel.
F. Small wheel dismounted, so as to show the iron pins, set in a square form, with their collar, in the wheel, and secured by a key.
R. Key which secures the said pins.
P. Bridge which holds firm the boxes.
O. Wire loops beneath the glass rod, serving to guide the silk thread.
M. Reels, holding each six hanks of silk.
Z. Leather band, placed outside the spindles, to twist the silk.
Y. Space betwixt one column and another, containing a range of reels and bobbins.

The Planet Neptune. By Mr. J. F. W. Herschel.

In the Athenæum of Saturday week, [No. 1097,] mention is made of an intention on my part to discuss the question of the identity of Neptune, in terms which seem to convey an impression that I am engaged in a special work on the subject. This is not the case.

In my forthcoming "Outlines of Astronomy," the printing of which is in progress, and in fact nearly completed, an account of this great discovery will, of course, appear; and it will contain, (in pursuance of the plan of the work,) a brief explanation of the leading features of the discovery, and of the mode in which it has happened that elements, (as it appears,) very wide of the truth, have yet been able so well to satisfy the numerical conditions of the case. As to the question of identity, it must be regarded as defunct, having died a natural death, consequent on the calculation of the perturbations which the new planet actually produces on Uranus.—Prof. Peirce, (of the Harvard University, U. S.,) has recently communicated to the American Academy of Arts and Sciences an elaborate computation of these perturbations; which he prefaces by a statement that, "having completed his investigation into the action of Neptune on Uranus, he has ascertained that this planet will completely account for the observed irregularities in the motions of Uranus, provided that mass of Neptune is adopted which is derived from Mr. Bond's Observation of Lassell's Satellite." A curious point is raised by these calculations of the American geometer: since it appears from them, (assuming their correctness,) that the perturbations actually produced by Neptune exceed in a very high ratio the amount of those assigned either by M. Leverrier or by Mr. Adams, and in a still higher, the *apparent* perturbations which served as the groundwork of their calculations; their real extent being completely masked by the errors existing in the elements of the old ellipse. As the computations in question, though somewhat laborious, are by no means difficult, they will probably not long remain unverified. Perhaps the most singular feature in the whole history is the apparent paradox, that the *logic* of the processes by which those geometers arrived at the true place of the unknown planet, is quite unimpaired by this conclusion; and would have remained so were the co-efficient of the term on which it depends ten times greater, as it might have been, had the distance of Neptune been but very little different, *the acting forces remaining almost precisely the same.*

Collingwood, Nov. 11, 1848. Lond. Athen., Nov. 1848.

FRANKLIN INSTITUTE.

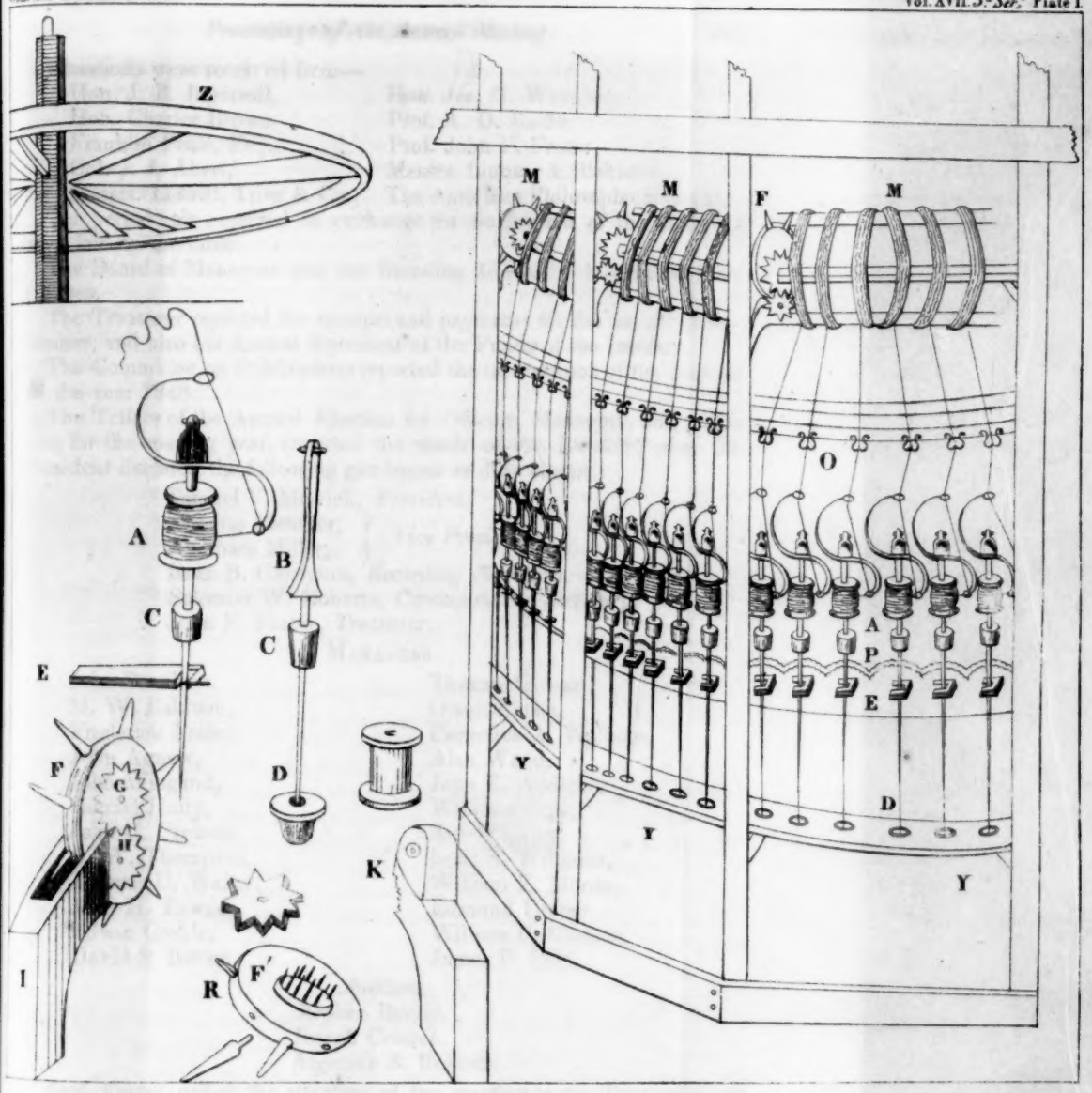
Annual Meeting.—Election for Officers.

The Annual Meeting of the Institute was held at their Hall, January 18th, 1849.

S. V. Merrick, President, presiding.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.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Donations were received from—

Hon. J. R. Ingersoll,	Hon. Jas. D. Westcott,
Hon. Charles Brown,	Prof. A. D. Bache,
Franklin Peale, Esq.,	Prof. John F. Frazer,
Col. J. J. Abert,	Messrs. Lindsay & Blakiston,
Messrs. Leavitt, Trow & Co.,	The American Philosophical Society.

The periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Board of Managers and the Standing Committees reported their minutes.

The Treasurer reported the receipts and payments for the month of December, and also his Annual Statement of the Funds of the Institute.

The Committee on Publications reported the transactions of the Journal for the year 1848.

The Tellers of the Annual Election for Officers, Managers, and Auditors, for the ensuing year, reported the result of the Election, when the President declared the following gentlemen as duly elected:

Samuel V. Merrick, *President.*
Thomas Fletcher, } *Vice Presidents.*
Abraham Miller, }
Isaac B. Garrigues, *Recording Secretary.*
Solomon W. Roberts, *Corresponding Secretary.*
John F. Frazer, *Treasurer.*

MANAGERS.

John Struthers,	Thomas Stewart,
M. W. Baldwin,	Owen Evans,
Frederick Fraley,	Cornelius A. Walborn,
John Agnew,	Alan Wood,
John Wiegand,	John E. Addicks,
Samuel Hufty,	Williams Ogle,
John C. Cresson,	Asa Whitney,
A. W. Thompson,	Isaac S. Williams,
Thomas U. Walter,	William E. Morris,
John H. Towne,	Edmund Draper,
Edwin Greble,	William P. Cresson,
David S. Brown,	James P. Ellis.

Auditors.

Stephen Byerly,
Joseph Cresson,
Algernon S. Roberts.

Prof. Frazer called the attention of the meeting to the Topographical and Hydrographical Map of Delaware Bay and River to the Head of Tide Water, presented to the Institute from the office of the Coast Survey, and now hanging in the Hall. He stated that such a chart of our harbor and approaches to the city had been much wanting, the errors in those in use previous to the commencement of the survey being such as to render the ships' observations for position entirely useless. He particularly asked attention to the great beauty of the work, and to the cheapness of the map, owing to the liberality of the government in distributing them at such a price as to pay merely for the printing and paper.

Dr. R. M. Patterson exhibited to the meeting specimens of California gold and cinnabar, and a specimen of African gold dust for comparison with that of California. He stated that the average fineness of the California specimens, of which a value of about $50,000 only had been received at the Mint, was about 894; the remainder of the metal was silver. The yield of the cinnabar, which was asserted to be about an average specimen, was 33 per cent. of mercury.

Prof. J. C. Cresson exhibited specimens, both crude and prepared, of a substance recently obtained by Mr. Blake of Akron, Ohio, and beginning to be extensively used as a fire-proof material for covering the roofs of buildings.

Mr. Phleeger described and illustrated by drawings, an improvement in the locomotive engine, invented by him, and successfully employed for a year past upon the Philadelphia and Baltimore Railroad. The object of the improvement is to prevent the racking motion caused by the alternating motion of the two outside cylinders—which is found to be so destructive both to the engines and the road. Mr. P. also explained an improved method of constructing the connecting rods, and a new arrangement of the fire-box, so as to permit the use of anthracite coal. We hope soon to present to our readers a description of these improvements, with the necessary drawings, by Mr. Phleeger himself.

Prof. Frazer exhibited a number of engravings of the impressions obtained by Donne's Daguerreotype Microscope, and explained the method in which they were obtained, and the advantages likely to result from them in microscopic studies.

Dr. Winslow exhibited a newly invented lamp for the burning fluid, so contrived as to avoid the danger which now exists in filling the lamp while lighted. The lamp is constructed with a double cap; the wick is in two pieces, the lower piece of which is immersed in the liquid and rises above the lower cap; the upper piece passes through the tubes in the upper cap, and when this is in place its lower end is in contact with the upper end the lower wick. In filling the lamp, this upper cap may be unscrewed and removed to any distance, the wick attached to it retaining sufficient fluid to burn for some time; the under cap is then unscrewed and the lamp filled, when the caps are replaced, and the lamp presents all the appearance of an ordinary one.

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Board of Managers.

At a meeting of the Board of Managers, held January 24th, 1849, Mr. Thomas S. Stewart was elected Chairman, and Messrs. Cornelius A. Walborn and Williams Ogle, Curators for the ensuing year.

BIBLIOGRAPHICAL NOTICES.

Smithsonian Contributions to Knowledge.

The Third Volume of the Smithsonian Contributions to Knowledge has been published, a handsome quarto volume of 306 pages, and a number of well executed lithographic plates and wood-cuts, under the title of

"*Ancient Monuments of the Mississippi Valley, comprising the results of Extensive Original Surveys and Explorations, by E. G. Squier, A. M., and E. H. Davis, M. D.*

It is known to most of our readers, probably, that "James Smithson, Esq., of England, bequeathed his property in trust to the United States of America, to found at Washington an Institution which should bear his own name, and have for its object the increase and diffusion of knowledge among men." The government accepted the trust and founded the Smithsonian Institution, of which Professor Joseph Henry, formerly of Princeton, and celebrated for his physical researches, is the executive head, with the title of Secretary. This is their first contribution to the *increase* of knowledge—although we owe them already several valuable quarto pamphlets devoted to its *diffusion*.

Of the philosophical merits of the work we cannot speak, but they are certified to by the high authority of the American Ethnological Society, Mr. Marsh of Vermont, and Dr. S. G. Morton of this city: but the volume is very handsomely got up, and will be, no doubt, very welcome to our Archæologists. F.

Map of the Delaware Bay and River, founded upon a Trigonometrical Survey, under the direction of F. R. Hassler and A. D. Bache, Superintendents of the Survey of the Coast of the United States.

Report of the Superintendent of the Coast Survey, showing the progress of the work for the year ending November 13th, 1848.

We have received from the office of the United States Coast Survey, a copy of the chart of Delaware Bay and River, for which we return our acknowledgments. The annual report of the Superintendent contains the history of the work for the year ending 13th November, 1848, as well as a brief notice of its progress under the superintendence of Prof. Bache, made in conformity with the instructions of the Coast Survey.

In our notice of last year's report, (*Journal, vol.* xv, *p.* 213,) we took occasion to draw the attention of our readers to the importance of such surveys, and to explain briefly the general method in which they are executed. The minute examination of the recently published chart of Delaware Bay suggests to us some remarks upon the method in which the work has been conducted.

The U. S. Coast Survey was first efficiently commenced by the late lamented Mr. Hassler, in the year 1827,—[It was first recommended to Congress by President Jefferson, in 1807, and Mr. Hassler sent to England to procure instruments, where he was detained until 1815, owing to the war. In 1817 he began the work, which was, however, suspended by Congress in 1818,]—since which time the work has been carried into every State on our Atlantic frontier. In 1842 the primary triangulation covered 3577 square miles, extending from Connecticut to near Philadelphia; the secondary triangulation exceeded the primary, extending from Narraganset Bay to Cape Henlopen, and covered about 11,000 square miles; while the

topographical surveys covered about 4200, and the hydrographical about 5600 miles. Since the death of Mr. Hassler, in November, 1843, "an area of 17,555 square miles has been triangulated; the topographical surveys with the plane table have covered 2318 square miles, and embraced an extent of shore line, roads, &c., of 7179 miles. The hydrography has covered an area of 20,086 square miles, of which 16,824 were principally off-shore or deep sea works." *(Report for* 1848, *p.* 13.*)* Shewing an average of about three times the amount of triangulation, rather less than 1½ times the amount of topography, and about *nine times that of the hydrography*, (which, on our coast, is by far the most important work,) done per year by the present Superintendent.

We must not be understood as meaning to convey any imputation against the memory of one who deserves as well from our country as the late Mr. Hassler, who devoted the energies of nearly his whole mature life to the prosecution of this great work. On the contrary, he deserves great praise for the efficiency which, under such unfavorable circumstances, he succeeded in giving to it. And we believe that, notwithstanding all the obstacles and discouragements attending it, his work will compare, both for accuracy and rapidity, with that of similar European surveys. But we want to shew (and think we have done it) that the present Superintendent is also devoting his energies to it, and that he must have taken advantage of every favorable circumstance to obtain such striking results.

A comparison of the yearly expenditure will shew nearly as favorable results. In 1844, (under Mr. Bache,) the cost of 15 parties, with less office work, was $100,000, while in 1847, 30 effective parties were kept at work for $130,000, or about 1½ times the work at the same expense. This increased economy has been obtained by the application of all the cardinal virtues of a geodetic surveyor, from the inventive genius which supplies improved forms of apparatus, and new methods of observing, to the business talent which organizes a system of strict accountability. It is impossible to compare ours with other surveys, for of none others are the yearly expenditures made known to the public; nor would the different circumstances of the survey allow of the comparison, if we had this knowledge. But the following paragraph of the report (*p.* 3) shews a comparison with other government work, of a somewhat similar, though far inferior kind, which is strikingly in favor of the economical administration of the Coast Survey:—

"The topographical survey referred to furnishes what is usually derived from a local survey, namely, a map of a portion of the surface; it gives all the details, natural and artificial, of the country, which is more than an ordinary land survey presents, and more than is attempted in the surveys of the public lands. It is admitted to be desirable, if not too costly. The cost of one cent and ninety-four hundredths per acre, ($12·41 per square mile,) stated by the Commissioner of the General Land Office in 1845, from careful averages, to be that of the land surveys to that time, is certainly less than has been paid by other governments for similar work.— The estimated cost of six dollars and thirteen cents per lineal mile, ($6·13) for 1846, is quite low, and even the maximum cost, in some of the land districts, of ten dollars and forty-nine cents, ($10·49,) is, beyond a doubt, reasonable. The cost of the topography of the coast survey in 1847, the

year now reported upon, was, exclusive of drawings, *one cent and forty-five hundredths per acre*, (less than the average cost above stated,) including the drawings, two cents and fifteen hundredths per acre, or two mills per acre greater than the cost above stated. Converting the lineal surveys of the coast survey into area by the average proportion deduced from four years, 1844 to 1848, the cost per lineal mile, without drawings, was three dollars and forty cents; ($3·40;) with drawings, five dollars and ten cents, ($5·10;) both less than either the actual cost of the land surveys up to 1845, or the estimated cost for 1846.

"As the other operations of the survey are beyond those of ordinary land surveys, they might be expected to add greatly to its cost; and as it is admitted that the work, topography inclusive, derives its highest importance from these other results, the question might be turned upon their actual value and not their expense. The geographical determinations of the points and bearings are indispensable to an accurate map even of a moderate extent of surface. If a map or chart is desirable, it should certainly be constructed on correct mathematical and physical principles. What these results cost, however, is a matter of simple computation; and taking the fiscal year just passed, which is unfavorable, as during that period a base was measured, and reconnaissance and triangulations made without topographical work, all of which, with the astronomical and magnetic observations, are included in the estimates, the whole cost per acre, including the topography, is three cents and fifty-two hundredths without drawings, or four cents and thirty-three hundredths with. Per lineal mile, (taking the area as if divided into squares,) the cost of the whole geodetic survey is, with the topographical drawings, eleven dollars and twenty-five cents, ($11·25,) and without them ten dollars and six cents; ($10·06;) less than the maximum paid for the survey of the public lands. The work thus proves to have a character, in reference to expense, the very reverse of what is sometimes attributed to it. It not only furnishes accurate scientific details and practical results, but it affords them at a very moderate cost. The relief to the coast survey appropriation by the detail of officers of the army, does not sensibly vary the above result in the year referred to, as the war had taken all the line officers from service on the work. The officers of the navy are employed in the hydrography, and not in the land work which is above referred to."

The charts which have been issued from the office of the Coast Survey are very beautiful specimens of topographic drawing and engraving, and in the highest degree creditable to the office; and so far as our means of verification allow us to express an opinion, are extremely accurate;—a conclusion, however, which every one can come to much more certainly and satisfactorily, by examining the precautions which are used to make them so. The necessity of such charts for the Delaware Bay will be easily appreciated, from the fact, here well known, that to a vessel entering that Bay by the old charts, the chronometer was of no manner of use,—the principal landmarks and shoals being so far displaced upon the charts as to be irreconcileable with the ship's observations. When the Coast Survey reached this bay, Mr. Hassler, then superintendent, very liberally and properly allowed the determinations of his parties to be communicated to